In this Issue: Experience with Sliding Sluice Gates at the Charles River Basin.—A Comparison of "Special" and "Stock" Hydraulic Turbines.—Passenger Traffic Handling, Manhattan Terminal, Brooklyn Bridge.

ENGINEERING NEWS

Founded 1874.
Volume 63. No. 21.

220 Broadway, NEW YORK, THURSDAY, MAY 26, 1910.

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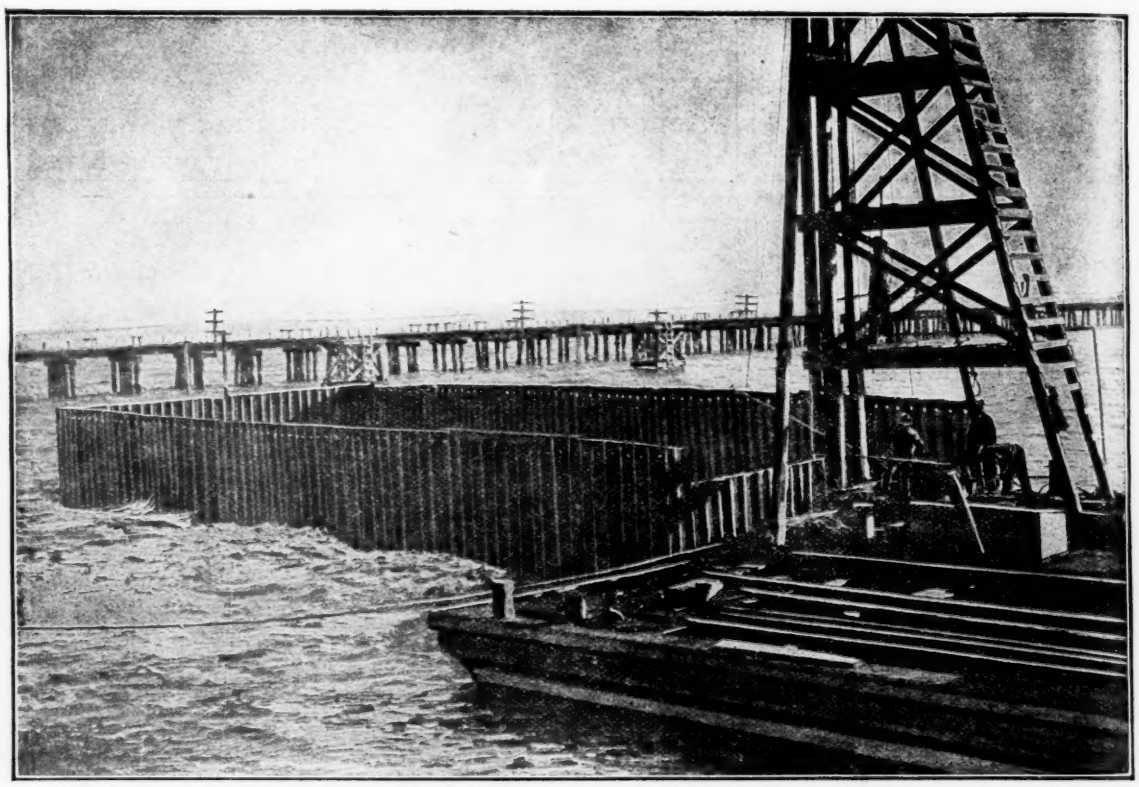

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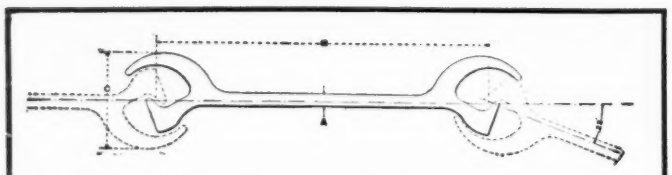

A		B		C
Thickness of Web	Weight per Square Foot of Wall	Distance Center to Center of Joints	Weight per Lineal Foot	Width of Joint Over All
½ inch	40.00 pounds	12¾ inches	42.500 pounds	3½ inches
⅜ inch	35.00 pounds	12¾ inches	37.187 pounds	3½ inches
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ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. 63. No. 21. 220 Broadway, New York, May 26, 1910.

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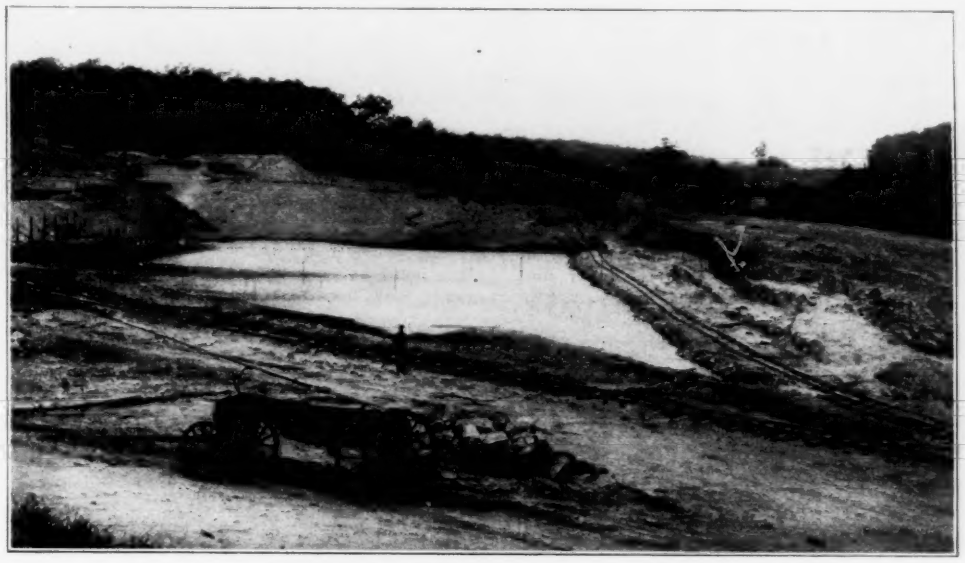
The Western High-Service Reservoir of the Water Works of Baltimore, Md.

By ALFRED M. QUICK,* Assoc. M. Am. Soc. C. E.

The Water Department of Baltimore, Md., is constructing a new reservoir of about 210,000,000 gals. capacity to provide additional reserve water storage for a distribution district called the Western High Service District. This district has a population of about 150,000 and a maximum daily consumption of about 20,000,000 gals. It is normally supplied by pumps at the Mount Royal Pumping Station taking water from one of the low-service reservoirs, and pumping through the distribution system into an old high-service reservoir in Druid Hill Park having a capacity of about 25,000,000 gals.

With such a small margin of storage capacity in excess of maximum daily consumption it has been only by good fortune that as a result of some breakdown either in the pumping station or the force main this storage has not been completely exhausted. Two or three times in recent years there have been breaks in the force main near the pumping station of such a nature that the supply in the reservoir was nearly exhausted before repairs could be completed. The necessity for greater storage capacity in this service for such emergencies was recognized over twelve years ago and provision was made in a loan at that time for an additional reservoir. The money was spent for other purposes, however, and several years elapsed before another loan could be authorized and approved. After that for about seven years there was dispute and litigation in regard to a site. Finally the site recommended by the Water Department was secured.



CONSTRUCTING DAM, WESTERN HIGH-SERVICE RESERVOIR, FOREST PARK, BALTIMORE, MD.

(A start is being made in placing selected material under water. At the left may be seen the bulkhead used to separate the clay puddle and the rock-and-earth fill inside of the basin.)

General Description of Site.

The site is a natural valley located in the extreme northwestern section of the city, near the margin of the district which the reservoir is to serve, and having an average elevation of about 150 ft. above that district.

The valley was entirely enclosed, except for a short space at the east end, by hills rising above the proposed high-water line elevation of the reservoir, 350 ft above mean tide. About 23 acres, or approximately two-fifths of the area of the site, was covered with timber and the remainder was cultivated land. A small stream ran through the valley, carrying the drainage from about a square mile of territory west and northwest of the site and also a small amount of sewage from a suburban settlement in that territory.

About 59 acres of land were purchased for the reservoir and surrounding roadways in the fall of 1907. At the same time the Park Board bought for park purposes about as much more land adjoining on the north, east and southeast, extending from one proposed boulevard to another. By agreement between the Reservoir Commission and the Park Board the shape of the reservoir and the layout of the surrounding paths and roadways was worked out by the Park Board's consulting landscape architect, Mr. Frederick Law Olmstead, of Boston, to harmonize with his plans for the adjoining park lands and boulevards. All construction plans were, however, drawn up by the Water Department.

Preliminary Investigation of Site and Soils.

In order to determine the character of the material to be excavated, before plans were completed, we dug 41 wells about 6 or 8 ft. in diameter, and made 7 drill holes and about 50 auger holes, at various points on the site distributed so as to cover it fairly well. These wells and borings indicated that the general geological characteristics of the site were first a layer of top soil, then about 2 or 3 ft. of clay, under which was an irregular solid rock formation with pockets of clay, disintegrated serpentine called "rotten rock," and broken up hard rock of that nature. The solid rock was principally gabbro or trap rock and serpentine.

We also made some preliminary tests to determine how impervious to water the clay and rotten rock would be, and how suitable for use in puddle trenches and slope lining. Across the stream running through the reservoir valley we built a small dam about 5 ft. high, of clay taken from the site and hand rammed; with an inner slope of 2 to 1 and the down-stream side built against a plank bulkhead. This dam was allowed to stand for three or four months under a head of water which frequently overtopped it to a considerable depth.

A wooden box about 2 ft. in depth, width and length was filled with hand-rammed clay taken from the site, and a 1-in. pipe, with a pointed and perforated end, was driven into the clay to a depth of 15 ins. This pipe was then charged with water under a head of 40 ft. and allowed to stand for four days.

Two lengths of 6-in. wrought-iron pipe each 1½ ft. long were capped at both ends, the bottom cap having a small gage cock tapped into it and the top cap being tapped for a ½-in. pipe. Into each of these tubes was first put some 3 or 4 ins. of graded gravel to provide an outlet to the cock for any water passing through the material above. Then one of these tubes was filled with clay and the other with rotten rock taken from the site, firmly rammed with a jack. Each of these tubes was then subjected to a water pressure of from 140 to 160 lbs. per sq. in. through the top cap for a time, and then left under a constant pressure of about 40 lbs. per sq. in. for about six months. All of these tests showed the clay and rotten rock to be practically impermeable, water penetrating the material in each case to a depth of not over 1½ ins.

Outline of Plans for Reservoir and Diversion Sewer.

Plans for construction were completed in May, 1908. The reservoir is of an irregular oval shape (Fig. 2) about 1,600 ft. long, 800 ft. wide, and 35 ft. deep from the surrounding berm to the

*Water Engineer, City Hall, Baltimore, Md.

bottom at all points, with a water depth of 30 ft. It has a periphery of about 4,200 ft., of which about 2,350 ft. is in embankment. The inner slope is 3 to 1 all around and the outer slope of the embankment is 2½ to 1. The embankment is increased by having a park road extending along its highest section about half way up the outer slope and also by a mall in front of the gate-house. The maximum height of embankment (Fig. 3) is about 85 ft. and the maximum depth of excavation about 45 ft. The slopes rise up to a berm 15 ft. wide, extending all around the reservoir, on which is to be a 5-ft. gravel path. The gate-house is at the southeast end of the reservoir, at a point where there was a slight depression in the original hill and nearest to the section of the city the reservoir is to supply. The foundations are of reinforced concrete, with one influent chamber and two effluent chambers. The 48-in. influent pipe changes from cast-iron to reinforced concrete just outside of the gate-house foundations and from there runs about 1,000 ft. to a delivery pool near the center of the west end of the reservoir. The two effluent chambers extend outside of the foundations through to the inner slope with reinforced-concrete side walls. In each of the effluent chambers are three sluice-gates placed one above the other so that water can be drawn from different depths in the reservoir. From the gate-house one 48-in. influent pipe and two 48-in. effluent pipes lead to an underground gate vault at the foot of the slope below the mall. In this vault these pipes are all connected with division gates so that they can be used interchangeably. From the gate-house, also, a 20-in. drain pipe extends to an outlet in the bed of a stream at the foot of the hill.

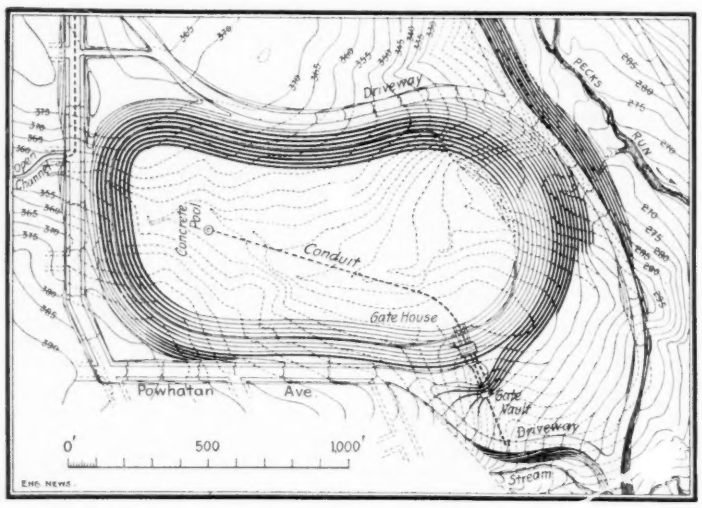


FIG. 2. GENERAL PLAN OF WESTERN HIGH-SERVICE RESERVOIR, FOREST PARK, BALTIMORE, MD.

The plans also included about 2,100 ft. of diversion sewer to divert the drainage from the stream in the reservoir valley under streets around the reservoir into a stream flowing south along the east end of the site. About two-thirds of this sewer is 69 ins. and about one-third 60 ins. in diameter. It is constructed of concrete, with a single-course invert lining of hard-burned red brick. On account of the steep grade in the street where the 69-in. sewer is laid there are two drops, one of about 15 ft. with 14 granite steps, and the other of about 9 ft. with 9 granite steps.

It was estimated that there would be about 300,000 cu. yds. of excavation in excess of what would be needed for the reservoir embankment. The plans provided for utilizing most of this excess in filling in a deep valley on the Liberty Road Turnpike (Fig. 2) which borders the reservoir and park property on the north side and which is to be a boulevard and is to be completed and paved out of a $5,000,000 State Roads loan; and also for grading and making roads on the park land approaching the reservoir from the southeast.

The original plans for making the reservoir a water-tight basin provided for a continuous thin reinforced-concrete cut-off wall (Fig. 3) extending from the original ground surface down to solid rock, and running around the east or embankment end of the reservoir, about under the toe of the inner slope, to the point on each side where the surface of the solid rock rises to the level of the reservoir bottom. Starting from the top of this reinforced-concrete wall, a thick rolled-clay lining was to be run up the inner slope of the embankment to just above the high-water line. From the ends of the concrete wall a wall of clay puddle was to be made in trench around the west or excavation end of the reservoir, extending from solid rock up to just above the high-water line. We planned to use reinforced concrete because our borings did not show sufficient clay on the site to make both the cut-off wall and the slope lining.

Contracts and Estimates of Cost.

We decided that we could get more favorable bids from contractors by first having the site cleared of timber so that a comprehensive view could be had of the whole layout. Consequently, a contract for clearing and grubbing was let early in 1908 for $2,300, the contractor taking the timber.

Bids were asked on the reservoir and diversion sewer separately, and on the unit basis, except for masonry construction like the sewer itself, the gate-house and gate vault, and other small details the exact shape, size or content of which could be definitely predetermined. Ten proposals were received for constructing the reservoir, ranging in amount from $494,810 to $837,231; and 13 proposals were received for constructing the diversion sewer, ranging in amount from $33,572 to $73,986. Our estimates of the cost based on the estimated quantities were $534,198 for the reservoir, and $35,952 for the sewer. Contracts were awarded to the lowest bidders, Lane Brothers Co. & Jones, of Virginia, on the reservoir, and C. B. Clark & Co., of Baltimore, on the diversion sewer.

Description of Construction.

Work was begun on both contracts in the first week of July, 1908. On the reservoir site the top soil and clay were first removed with wheel scrapers and piled at convenient places just outside of the limits of the area to be excavated or covered with embankment. About 49,000 cu. yds. of top soil and about 55,000 cu. yds. of clay were thus excavated. As we estimated it would take 80,000 cu. yds. of material to make the puddled cut-off wall and slope lining, the excavation thus confirmed the indication of our borings as to the deficiency in the amount of clay on the site for that purpose. However, because of the difficulty of making a thin reinforced-concrete wall in a trench 50 or 60 ft. deep, as was necessary to get down to solid rock, and because it would enable us to considerably reduce the cost of the cut-off wall, we decided to utilize enough of the soft rotten rock (which our experiments had shown to be impermeable when puddled) to make up for the deficiency in the amount of clay, and puddle it with the clay in the cut-off wall trench (see Fig. 3).

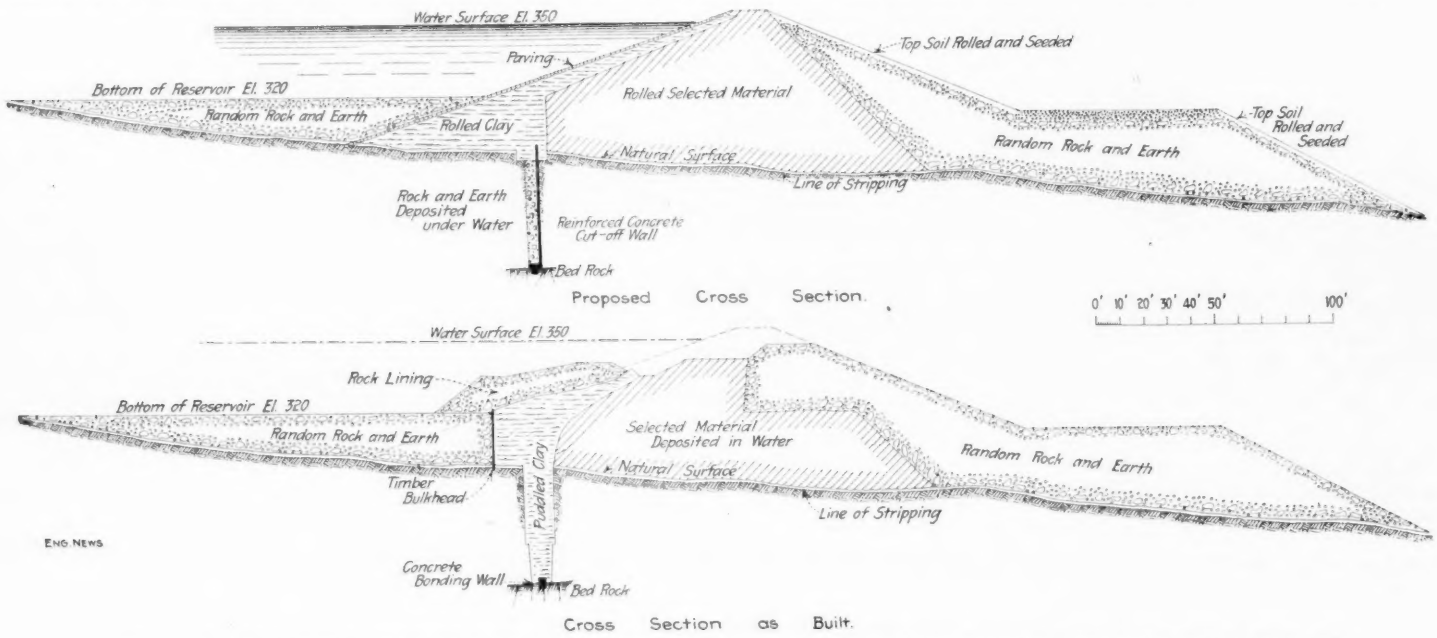


FIG. 3. PROPOSED AND ADOPTED CROSS-SECTIONS FOR DAM OF WESTERN HIGH-SERVICE RESERVOIR, BALTIMORE, MD.

Work on the puddle trench around the east end of the reservoir was started in the latter part of July, 1908, while the work of scraping off the top soil was in progress. Work on the puddle trench at the west end of the reservoir was started soon afterwards, in the early part of September of that year. In the latter part of

August, the first steam shovel commenced work on the excavation of Eleventh St., which borders the west end of the reservoir site and through which the diversion sewer runs, to cut it down to the established grade. In the latter part of September a second steam shovel was started excavating on the south side of the reservoir basin, and about a month afterwards the first steam shovel having finished the cut in Eleventh St., began excavating on the north side of the reservoir basin. All of the material excavated

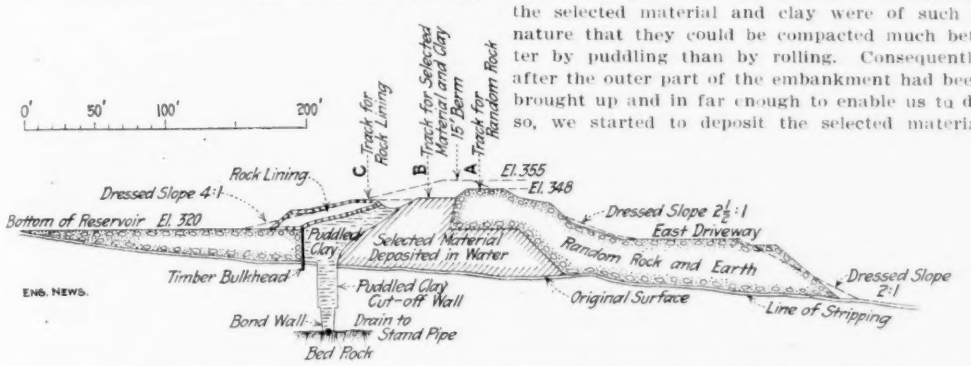


FIG. 4. SKETCH ILLUSTRATING METHOD OF PLACING MATERIAL IN DAM FOR WESTERN HIGH-SERVICE RESERVOIR, BALTIMORE, MD., AS OF DEC. 1, 1909.

Material Placed Up to Date Given.

	Cu. yds.		Cu. yds.
Puddled clay	16,310	Random rock and earth	122,458
Selected material	88,803	Waste on East driveway	67,009
Rock lining	18,398	Backfill below Elev. 320	28,457

by the north shovel from the reservoir basin for the first three months of its operation was placed in the dam. After that all earth classified as "selected material" excavated by it was placed in the inner section of the dam and all waste material was placed either in the outer section of the dam, in the fill on the Liberty Road, or on the private property adjoining that road on the north where, in order to obtain possession of the strip of land necessary to widen out the road from 66 ft. to 100 ft., we were compelled to put about 50,000 cu. yds. to fill in low land up to the new grade of the road.

The material excavated by the south steam shovel was placed from the start in the dam and in the fill on park land adjoining the reservoir to the southeast, all select material going in the inner section of the dam and the waste material going in the outer section of the dam and in the fill on park land.

The cut-off wall trench under the dam at the east end of the reservoir was down to solid rock for a length of several hundred feet by the winter of 1908, but the clay was so wet or frozen that none of it could be deposited in the trench until the latter part of January, 1909. Before the clay was put in, a concrete key wall was constructed on the solid rock in the center of the bottom of the trench about 2 ft. high and tapering from 8 to 16 ins. thick. As several springs were encountered in the bottom of the trench, in order to collect the flow from them and carry it outside of the trench 2-in. drain pipes were embedded in the concrete key wall running each way from the lowest point and branching with 1-in. pipe to each point where springs showed on the inner side of the trench; the 1-in. pipe branches being also embedded in concrete walls branching from the main key wall.

On account of the great depth of the trench and the somewhat unstable condition of some of the earth back of the sheeting, the contractors at first objected to depositing the clay under water unless the trench braces should be left in or unless the city would assume all risk if the braces were removed. Consequently we made an experiment to see if the clay could be deposited dry and be sufficiently compacted with heavy hammers and hand rammers, but we found it impossible to sufficiently compact the clay in that way. The contractors were therefore directed to puddle the clay and remove the braces gradually as the trench was filled. By using temporary braces and shoring, all braces were removed from the trench, leaving a solid puddled wall, without any difficulty and with no accident of any kind. As the elevation of the ground surface at the top, and of the solid rock at the bottom of the trench, varied considerably, it was necessary to puddle the trench in sections between berms made of dry clay. In this way the puddle trench was filled up to the elevation of the original ground surface.

Our original intention, when the plans were drawn, was to make the embankment by rolling in layers both the selected material portion and also the clay lining. We found, however, that the selected material and clay were of such a nature that they could be compacted much better by puddling than by rolling. Consequently after the outer part of the embankment had been brought up and in far enough to enable us to do so, we started to deposit the selected material section in water. When the selected material section had been thus built up to the level of the original ground surface at the lowest point on the puddle cut-off trench, we built a timber bulkhead just inside of and parallel to the inside line of this trench, extending each way out to a point where the original ground surface was at the elevation of the finished bottom of the reservoir, in order to confine the clay puddle to as neat a line as possible and also so that we could fill in the bottom of the reservoir with loose rock and earth and keep that material from running over into the clay puddle section. This bulkhead was built up gradually and simultaneously with the clay puddle on one side and with the loose rock and earth fill on the other to the finished level of the reservoir bottom (see view on p. 601).

We considered various methods for building the embankment above the finished bottom of the reservoir that would allow us to deposit both the clay lining and select material section under water and at the same time to carry the clay lining up the slope from the top of the puddle trench to just above the high-water line of the reservoir. The method adopted was as follows: Berms about 6 or 7 ft. high were built approximately on the line of the inner slope and heavy enough to prevent the puddled material from lifting them or pushing them out of place. Then sufficient clay was dumped on the inside face of these berms to hold the water. Meanwhile the outside rock-and-earth section of the dam was kept up to an elevation about 6 or 7 ft. above the top of these inside berms. When we were ready to make one lift of the selected material and clay lining, this rock-and-earth section was benched out on the inside with select material at the same elevation as the top of the inside berm. Then about 6 ft. of water was run into the space between this bench and the berm and select material was dumped in from one side and clay from the other until the space was entirely filled, the water meanwhile being drained off through a trench at one end of the fill. In this manner the clay-and-selected material portion of the embankment has now been built up to about 13 ft., and the rock-and-earth section up to about 5 ft., from the finished top of the dam. All of this material was deposited from dump cars; the rock-and-earth and selected material being taken direct from the excavation and the clay being scraped from the piles onto platforms built over a side track from which it was dumped or shoveled into the cars (see Figs. 4 and 5).

The original plans also provided for paving the entire inner slope of the embankment, from the bottom up to 3 ft. above the high-water line, with stone to be taken from the excavation and roughly squared and bonded. We decided, however, that this was not only unnecessary, but that we could save considerable money and at the same time produce a much better appearance by rip-rapping with small stones all the way around the reservoir a section of the slope from 10 ft. below to 3 ft. above the high-water line. The slope will be dressed off to a neat line and benched in to hold the toe of the rip-rapping and then the small stone will be taken in cars from the crusher, dumped in position from tracks to be laid on the top of the embankment, and then raked over to an even thickness.

By the first of March, 1909, the contractors had the dam and waste dumps in condition to enable them to push the steam-shovel excavation in the reservoir basin as fast as possible. They first considered the advisability of adding one or two extra shovels to the two that were then working, but finally decided that they could work to better advantage and make greater headway by running two shifts a day on the two shovels. It was to their advantage to do this because a State law compelled them to limit the work of one shift to eight hours a day. Consequently

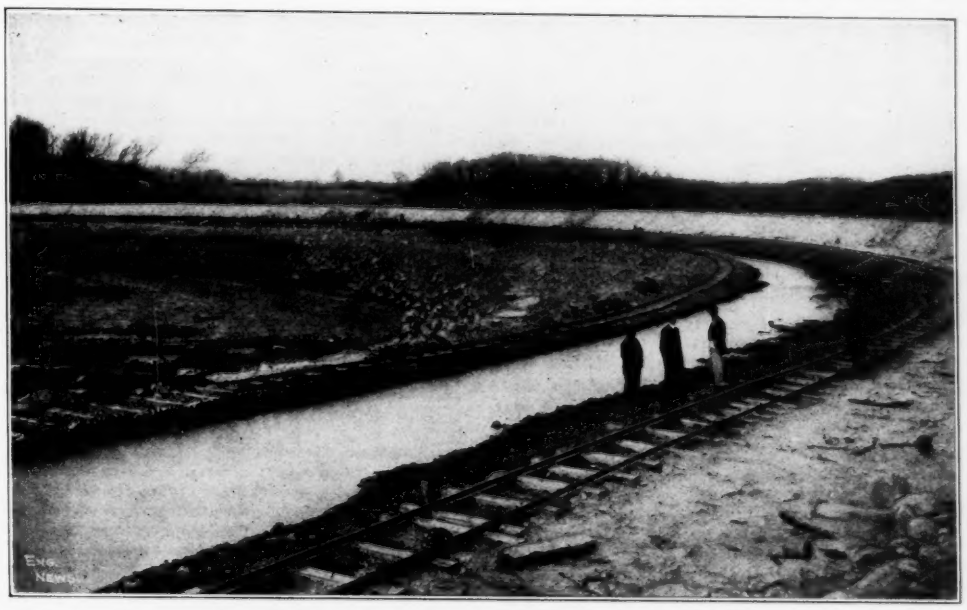


FIG. 5. CLOSING IN A LIFT OF SELECTED MATERIAL AND CLAY LINING ON THE DAM FOR THE WESTERN HIGH-SERVICE RESERVOIR OF THE BALTIMORE WATER-WORKS (SEE FIG. 4).

about the middle of May, 1909, they began double shifting on the steam-shovel work. From that time on to the first of December, when bad weather began, the two steam shovels excavated about 300,000 cu. yds. of material from the basin, or an average of over 46,000 cu. yds. a month, over 60% of which was solid rock. As the greater part of the loose rock and earth lay in comparatively small pockets or layers, nearly all of the material had to be blasted before it could be excavated.

Up to Jan. 1, 1910, 510,000 cu. yds. of material, exclusive of clay and top soil, had been excavated from the reservoir basin, of which about 260,000 cu. yds. had gone into the dam. The remaining 250,000 cu. yds. of waste material have been distributed as follows; about 96,000 cu. yds. were used to fill in and widen the Liberty Road at a low point just northeast of the reservoir where it borders Park land, about 67,000 cu. yds. were used to fill in a deep hollow and make roadways on park land adjoining the reservoir on the southeast; about 7,000 cu. yds. were used to fill Eleventh St. up to grade in the depression just west of the reservoir basin, and the balance of about 80,000 cu. yds. was used to fill up low land on one private property just west of Eleventh St. and on another just north of Liberty Road.

Before the fill could be made on Liberty Road it was necessary that two culverts should be constructed to carry two small streams through. Our diversion sewer terminated at one of these streams and we had our reservoir contractors build there a 30-in. cast-iron pipe culvert from the north side of the fill up to the sewer outlet and from there to the south toe of the fill, a reinforced-concrete box culvert about 6 × 6 ft. in cross-section. As the other stream carried drainage which the new storm sewer system that the Sewerage Commission is now building would eventually have to take care of, that commission built the culvert to carry its flow through the fill. This culvert is constructed of concrete and is 9½ ft. in diameter and about 245 ft. long. Before the fill was made on the park land to the southeast of the reservoir, drain pipes had to be laid, one of which was for carrying the flow of a small stream under the fill and the other was the 20-in. drain pipe from the gate-house which has been referred to.

Excavation for the gate-house was commenced early in September, 1908, and about two months later work was begun on the concrete foundation. The substructure is now completed up to within 8 ft. of the top, and all gates, valves and other castings are set. It is faced with granite from about 10-ft. below the high-water line of the reservoir up to the top. The gate-house superstructure is to be of tapestry brick with Indiana limestone trimmings and a mosaic floor. The gate vault is entirely completed. Over two-thirds of the 1,000 ft. of 48-in. reinforced-concrete inlet conduit has been made up and a small portion of it has been laid in place. About 58,000 cu. yds. of material yet remain to be excavated from the reservoir basin, of which about 38,000 cu. yds. will go to complete the rock-and-earth and selected-material sections of the dam. About 11,700 cu. yds. of clay remain in the stored piles which will be placed to complete the clay lining of the dam. All of the rip-rapping and top soil is yet to be placed.

The diversion sewer was entirely completed by Oct. 1, 1909. We estimate that the reservoir will be finished by July, 1910, or just two years from the time that the work was begun. This is a shorter time than was taken to build any of our seven present storage reservoirs, even those of much smaller capacity. That so much work has been accomplished in such a comparatively short time has been due partly to the favorable weather conditions but principally to the good organization, good machinery, and good management of the contractors, Lane Brothers Co. & Jones. The total cost of the reservoir, including land and engineering, will be about $700,000, or about $3,300 per million gallons capacity.

Work was suspended for the winter on Dec. 24, 1909, but was resumed about March 1, 1910.

All engineering in connection with the work is under the immediate direction of Mr. Emory Sadler, Assistant Engineer, and Mr. P. A. Beatty, Resident Engineer, and under the general supervision of the Water Engineer [the author of this article.—Ed.]

Origin and History of the Profession of Civil Engineering.*

The term "Engineer," as defining an occupation, is an old one; but it was originally applied only to persons in the military profession, and does not appear to have been used by civilians until the middle of the 18th century.

The root of both the words, Engineer and Engine, is found in the Sanscrit *jan*, to be born, from which came the Greek form γεν and the Latin *gen*, the latter being embodied in the old verb *genere*, with its compound, *ingenere* (changed into *ingignere*), to implant by birth, and in the later substantive *ingenium*, an innate or natural quality.

The old Latin verbs, *genere* and *ingenere*, gave rise to a French form, also a verb, *s'ingenier*. This is of great antiquity, and from its comprehensive and useful meaning it has continued in use down to the present time, being found continually in modern French writings. The import of it has nothing whatever to do with engines or machines, but is purely psychological. It is given in Littré's great French dictionary:—

> *Chercher dans son genie, dans son esprit, quelque moyen pour reussir.*

Now all authorities, including our own great Lexicographer, agree that this word is the true origin of the word Engineer, and thus we arrive at the interesting and certainly little-known fact that an Engineer is, according to the strict derivation of the term, not necessarily a person who has to do with engines, but anyone who seeks in his mind; who sets his mental power in action, in order to discover or devise some means of succeeding in a difficult task he may have to perform.

It would be impossible to give a nobler or more appropriate description than this of the manner in which our greatest engineering works have been produced, or the nature of the qualifications by which the greatest men in the profession have acquired their renown.

The use of the word in England is almost as old as on the Continent; for in the wardrobe account of King Edward I, A.D. 1300, occur expenses paid to several engineers for military artificers' work; and in 1344 it is stated that 321 artificers and engineers were borne on the books of the Ordnance.

Coming down to Queen Elizabeth's time, we find the term used by Shakspere. Writing about 1602, he makes Hamlet say (Second Quarto 1604):—

> For 'tis the sport to have the enginer
> Hoist with his owne petar, an 't shall goe hard
> But I will delue one yard belowe their mines,
> And blowe them at the Moone.

A few years later, in "Troilus and Cressida," Thersites is made to say (Folio 1623):—

> Then ther's *Achilles*, a rare Enginer. If *Troy* be not taken till these two undermine it, the wals will stand till they fall of themselues.

But there is another very remarkable passage where Shakspere uses the word, not in the sense of director of engines, but with the meaning before mentioned, "*Chercher dans son genie.*" It is in Othello (Folio 1623):—

> He hath atchieu'd a Maid
> That paragons description, and wilde Fame;
> One that excels the quirkes of Blazoning pens,
> And in th' essentiall Vesture of Creation,
> Do 's tyre the Ingeniuer.

It is remarkable too that in this place there is an approximation to the French original word *ingenieur*.

In Cotgrave's French and English Dictionary, 1611, the word *ingenieur* is translated "enginer, engine-maker, fortifier."

An Engineer, therefore, was, according to the most common acceptation of the term, a person in military service, whose business it was, not only to direct warlike engines or weapons (a duty transferred at a later period to the artillery officer), but to undertake the design and construction of fortifications, siege-works, roads, bridges, buildings, machinery, and all other works for military service which required knowledge, experience, and skill in the arts of construction.

Down to a recent period, the title "Engineer" was never applied to the constructors of similar works in civil life; yet the construction of such works generally has existed from time immemorial.

From the nature of the engineering works carried out by the Egyptians, Greeks, and Romans, we may be fully convinced that they were designed by men well acquainted with the philosophical principles current in their era; and as a matter of practice, how excellently they were done is testified by the manner in which they have stood the ravages of time. We may indeed doubt whether there are many engineering works of the present day which will, at the end of thousands of years, make as favorable an appearance as those of the ancients do now.

About the twelfth century, attention became strongly directed in France to the internal communications of the country, and an association was formed under the name of the "Frères Pontiers" (Brethren of the Bridge), with the object of building bridges wherever rivers were dangerous or difficult to ford. They extended branches over all parts of Northern Europe, and executed great numbers of important works, some of which still exist; as for example, the Old Bridge at Lyons, and another celebrated one over the Rhone at Saint Esprit, nearly half a mile long. The first stone London Bridge was also erected by them. This body is perhaps the earliest example of a definite, though small class of persons, expressly devoting themselves to civil works of an engineering character, and they might well have called themselves a Society of Civil Engineers had the name been in existence at that period.

It was not till some centuries later that the constructors of large civil works became such an important class as to require a special distinguishing technical name, and, just as the Frères Pontiers owed their incorporation to the wants of the roads of France, so the later and more important body were brought into existence by the needs of the rivers of Italy.

When the Italian Republics, in the twelfth century, revived the arts and sciences, they took measures to regulate and open the navigation by rivers long neglected, particularly on the Po and the Mincio. Three centuries later, Leonardo da Vinci added to his already great fame by the promotion of extensive works of navigation, and especially by his introduction of locks (invented by the brothers Viterbo in 1481) on the Milanese canals.

About the commencement of the 17th century, the great rivers in the north of Italy appear to have relapsed into a very bad condition, and the consequence was felt in disastrous inundations. The inhabitants of the districts became alarmed, and the most learned scientific men of the day were consulted as to how the evils might be remedied. To this impulse we owe a series of valuable theoretical and experimental studies, which lasted for a century and a half, and ultimately formed a thorough basis for hydraulic science and practice.

The knowledge thus acquired spread rapidly throughout Europe, and gave a great impulse to hydraulic operations. But now arose a want of competent men to execute them. The architects, who had formerly undertaken constructive works generally, found these new studies somewhat foreign to their own business, and were moreover already well occupied in their more legitimate employment. Hence a new class of practitioners was called for, who should devote their attention to hydraulic constructions, with all their necessary mechanical arrangements; and with these soon became associated constructive works which did not embody the artistic element, and might therefore be fairly dissociated from the profession of the architect. Thus the new class of men undertook to design not only river and hydraulic works, but roads, bridges, docks, harbors, mills, and machinery, and massive buildings generally. Such a class required a new name, and this was easily found. It could not fail to be noticed that the kind of work undertaken by these practitioners was exactly analogous to that allotted to the "Engineers" of the military service, and the new profession therefore adopted the same title, prefixing, however, the word "Civil," to indicate that they were civilians, and so to distinguish them from their military brethren.

Hence the origin of the term Civil Engineer, its true meaning being a person who devotes himself to occupations of the kind originally practised by military engineers, but who belongs to the civil and not to the military community.

It is probable that Smeaton was the first civil practitioner (if not absolutely, at least in England), who formally denominated himself an "Engineer." A report he made, dated July 11, 1761, on a canal in Staffordshire, is entitled:—

> Report by John Smeaton, Engineer, concerning the practicability, etc., of a navigable canal . . . as projected by Mr. James Brindley, Engineer.

He here awards the same title to his coadjutor, but there is no evidence that Brindley himself had previously used the term.

Smeaton had also the good sense to see the difficulty that this appellation might place him in, as pretending to assume a title hitherto only belonging to military men, and it was he who accordingly first adopted the prefix "Civil," to avoid all appearance of collision. He, however, only adopted the compound term on state occasions, usually styling himself simply "Engineer."

It is pleasant to think that the name, now become so common to denote a civil practitioner in engineering work, was originated and bestowed upon the profession by one of its members so thoroughly accomplished and so highly esteemed.

*An appendix to the Presidential address of Jas. C. Inglis, President of the Institution of Civil Engineers of Great Britain. Abridged from the account contained in the life of Sir William Fairbairn by the late Dr. William Pole, F.R.S., Hon. Secretary of the Institution.

An Unattended Lighthouse and Fog Signal at Guernsey in the English Channel.

To satisfy complaints of the unguarded coast found in entering what is known as Little Russel Channel and after all other solutions of the problem had been found impossible or impractical, an unattended light and fog-signal station, controlled from shore, was designed and built on an isolated rock known as Platte Fougère, northeast of the island of St. Peter

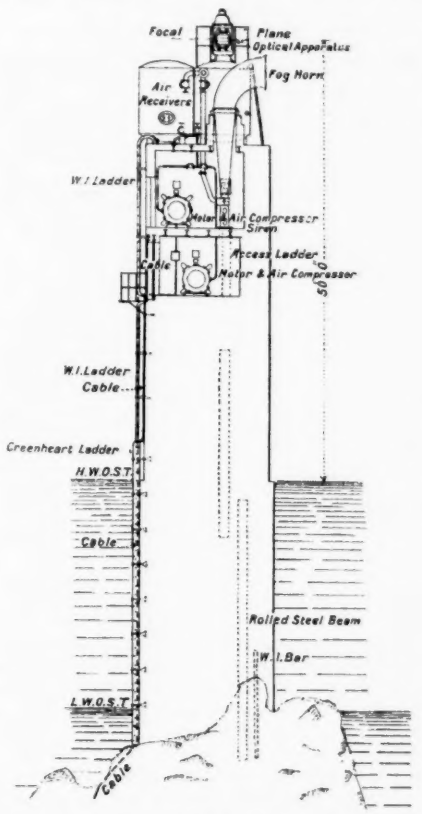


Fig. 1. The Unattended Lighthouse at Platte Fougere Rock near St. Peter, Guernsey.

near the coast of France. From a description in the London "Engineer" of April 8, the following information and the accompanying figures have been taken:

The provision of a powerful fog signal, to enable vessels to find and navigate the entrance to the Russel channel in foggy weather, was the main problem which had to be dealt with, the light being only an adjunct. The Grande Braye, Barsier de Braye and Platte Fougère form a tower of rocks at the entrance to the Russel channel extremely dangerous to a vessel approaching them, and especially so in foggy weather. The reefs all lie very low in the water, while behind them the coast line of the Island of Guernsey itself is also low. The rapidity of the tidal currents and the great rise and fall of the tide of 30 ft. make these dangers even more formidable. The possibility of erecting a structure to accommodate keepers was soon found to be out of the question, not only owing to the great cost that would be involved in constructing a rock lighthouse that men could live in, but also on account of the small area of the rocks, even the largest, the Grande Braye, providing insufficient area for a satisfactory foundation. Moreover, the expense and upkeep of an establishment for three or four keepers would have been almost prohibitive. In view of these difficulties, it was quite evident that some unusual scheme was necessary, and that which was put forward by Messrs. C. and D. Stevenson, the consulting engineers, was to build a tower of small diameter just large enough to hold the motors, compressors, fog horn, and the light, and to lay a submarine cable from the shore to the tower, the generating plant being erected on the land at Doyle Fort.

The station will be seen from Figs. 1 and 2. There are two chambers in the tower in which the motors, compressors, and siren gear are arranged. There is also a top platform for the compressed-air receivers, fog horn and light. On the advice of the engineers it was resolved to erect the tower on the Platte Fougère rock, this being the position in which the fog horn would be most serviceable to shipping. When it is stated that this rock is always submerged, except at low water of spring tides, it will be realized that the work of construction was difficult even in the best of weather. In consequence of the prevailing conditions, a small diameter but very strong octagonal tower, 14 ft. 6 in. and 17 ft. across the faces was chosen, because such a tower could be easily and quickly constructed, and such a narrow structure offered a minimum surface to the waves, thus avoiding the full stroke of the sea. The seas which the tower has to withstand are exceptionally heavy; but observation has shown that these heavy seas divide and split round the tower instead of striking and rising on it, thus bearing out the view of the engineers, that where feasible it is better to avoid heavy sea pressures rather than to court them.

The lower portion of the tower is concrete placed inside wrought-iron molds, while the upper part is of concrete. Iron bars are sunk into the rock in order to give the cement a good hold, and steel beams are built in to give strength where tension is most likely to take place on the concrete. The door, the upper platform and the light are 46 ft., 64 ft., and 80 ft. above the rock respectively.

The light is automatically worked by an acetylene-gas plant such as the consulting engineers have employed in Scotland for many years for unattended lights, the gas being supplied in cylinders containing acetone. The gas is turned off at sunrise and on at night by clockwork. An arrangement is provided to allow for the long nights of winter and the short nights of summer. A linear burner of a new type is placed inside an optical apparatus of 250 mm. diameter. The optical apparatus was supplied by the firm of Barbier, Bénard and Turenne, of Paris. The contractors for the acetylene plant were Messrs. Moyes, of Glasgow.

The equipment and buildings which have been erected ashore comprise a dwelling-house for two keepers, an engine room, a storeroom, offices, and a siren house. The site chosen at Doyle Fort was selected by the engineers after careful consideration with reference to the best place to land the submarine cable and the most suitable route for it to pass over. In order to provide for the possibility of the plant at the tower being out of order, the shore station is provided with a fog-horn and siren, so that in the event of failure to any part of the tower installation the equipment at Doyle Fort can be used. In the engine room there are two Crossley oil engines. On one side of each engine there is a three-phase alternator, while on the opposite side of one of the engines there is an air compressor, which latter serves as a stand-by, and is only used in the event of an accident to the submarine cable or the machinery in the tower. This compressor is of the quadruplex type, having four cylinders arranged radially round the annular casing, which latter forms a water jacket. Air is admitted to the cylinders through ports arranged in the pistons, with corresponding ports in the connecting-rod gudgeons, which ports open and close with the axial motion of the latter, thus dispensing with suction valves. The four connecting rods work upon a common crank-pin, which in this case is formed on the outer end of the oil-engine crank shaft and projects into the compressor casing, thus dispensing with a bearing on the compressor itself.

The plant on the rock consists of two quadruplex air compressors, direct coupled to induction motors of the squirrel-cage type. The motor-driven compressors are connected with the submarine cable and generating plant through a change-over switch, which can be operated either by hand or by means of an electro-magnet controlled from the mainland. As the compressors on the rock are required to run for long periods without attention, special arrangements have been made for continuous lubrication.

Siemens Bros., Ltd., were responsible for the manufacture and the laying of the cable connecting the generating station to the electrical machinery on the rock. Owing to the very strong currents and the heavy seas in the position in which the cable is laid, it was considered essential by the consulting engineers to employ a very heavy, double-sheathed, steel-armored cable. The cable, which has been employed, is 11 ins. in circumference, and weighs 45 tons per nautical mile. It has three large cores for carrying the three-phase current for power purposes, and two smaller cores for switch and telephone service. The five cores are insulated with gutta-percha. The size of the larger wires will be realized when it is stated that each conductor weighs about 1,100 lbs. per mile and the gutta-percha about 450 lbs. per nautical mile. A protection in the shape of a spiral brass tape has been provided, and the cable so formed is sheathed with heavy galvanized steel wires. There is also an outer armoring consisting of a band of six heavy steel wires laid on the cable with a 'short lay.' The overall diameter of the cable is about 3½ ins. By selecting a day on which there was little wind and awaiting slack water, the work of laying the cable on the sea bottom was accomplished without mishap.

The siren is of gun metal and it is driven by a small air motor. The air receivers are of steel. The clock gear is operated by a motor winding gear so as to be automatic, and it gives two blasts. The megaphone or horn is 4 ft. in diameter at the mouth. At the rock air receivers are provided having a capacity sufficient to give a powerful blast every 1½ minutes. The clock and siren have been fitted in the upper chamber of the tower, while the air receivers and water-cooling tank are placed on the bottom platform, but well out of the reach of the sea. One of the air receivers is utilized as a support for the lighting apparatus, and raises it 80 ft. above low water.

The engineers contend that the success already attained should encourage lighthouse and harbor authorities to approach in a similar manner any difficult problems they may have to face. It is maintained that this undertaking has proved that, by using a well tried automatic apparatus, it is perfectly feasible, by the aid of acetylene and electricity, to maintain an unattended light and fog signal of the first class on a nearly inaccessible rock, exposed to the full force of the Atlantic Ocean.

The cost of the whole work will amount to about $42,500, which may be considered a small figure when the exceptionally difficult nature of the situation is considered, as well as the powerful nature of the fog signal which has been erected, and the fact that an ordinary rock lighthouse establishment would have cost about $300,000. There will also be a saving in maintenance, as only two keepers will be required in place of four.

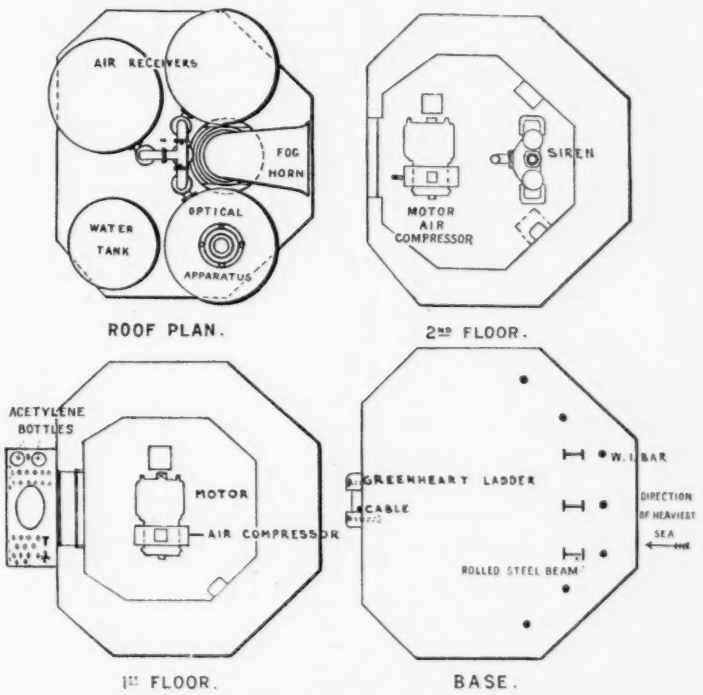


FIG. 2. SECTIONAL PLANS OF THE PLATTE FOUGERE DISTANTLY CONTROLLED LIGHTHOUSE.

A COKE-QUENCHING STEEL CAR is being built by the Atlas Car & Mfg. Co., of Cleveland, Ohio, for use at by-product coke ovens. The car has a steeply inclined floor of overlapping steel plates, and gates close against the lower side of this floor. The incandescent coke from the ovens is discharged by a pusher onto the car platform, and the car being moved along at the same time distributes the coke evenly in the car body. The car is then run under a quenching hood, where a spray of water is turned onto the hot coke. The car is then brought alongside receiving hoppers, the doors are opened, and the coke slides into them. The car may be either pushed by a small locomotive or operated by electric motors attached. The cars are in use at the Semet-Solvay by-product coke ovens at Milwaukee, and will be used also at the new coke ovens at Gary, Ind., where 3,000 tons of coke and 40,000,000 cu. ft. of gas are produced every 24 hours.

Passenger Traffic Handling on Elevated Trains at the Manhattan Terminal of the Brooklyn Bridge.

In regard to the number of passengers handled, the Manhattan terminal of the Brooklyn Bridge, New York City, with its total of 313,000 passengers per day, is probably the most largely used railway terminal in the world. The traffic is not evenly distributed but concentrates itself in large part into severe peak loads which occur during the morning and evening rush hours. The worst conditions occur in the evening, from 5.30 o'clock to 6.30, when the intensity of traffic is about 50,000 passengers per hour. In the morning the peak load is spread over a longer period and, even more important, the great bulk of the traffic through the terminal is inbound. The unloading of a large number of passengers presents little difficulty compared with that of loading.

The elevated lines, which come in on the upper deck of the terminal, handle nearly three-fourths of the total traffic in the rush hours. On the bridge itself, there are four tracks—one each way for elevated trains and one each way for surface cars. The surface cars pass from the inbound to the outbound track on eight loops at the (Park Row) street level. Passengers are unloaded at the entering end of the loops and the cars are loaded again after passing across the terminal to the outgoing side. The elevated terminal presents the more interesting problem.

The arrangement of the elevated tracks, which has been thoroughly discussed in earlier issues of Engineering News, is shown again in Fig. 1. The platforms are marked with the names of the elevated lines whose trains are there loaded, and the two platforms used for disembarking incoming passengers are marked "exit." The arrangement marked is the one used in the evening rush hours. Three of the seven platforms are island platforms, giving a total of ten loading edges. Only one of the platforms is used for both loading and unloading. Trains are regularly operated through this terminal—unloaded, transferred to the outbound tracks, loaded and sent back across the bridge—in the evening rush hour period at the rate of 61 trains per hour. The number of passengers (see table) accommodated on these 61 six-car trains in one hour is about 35,000, of whom about 32,000 are bound from Manhattan to Brooklyn.

Train Handling.

A highly efficient system of train and passenger handling has been developed of necessity to make possible this remarkable rate of train service. The disposition of the trains in the terminal from the time they enter from the incoming bridge tracks is controlled by a chief despatcher, stationed in the despatcher's box indicated by dotted lines near the extreme right of Fig. 1. This is at the east end of the terminal shed and is at a height of about 25 ft. above the track level. Windows in the east and west walls of the box afford a clear view of the tracks on the bridge approach and of the interior of the terminal. The despatcher himself operates the electro-pneumatically controlled switches at the points where the two bridge tracks branch into the four main terminal tracks.

The switches into the rear pockets are operated by a man stationed in the elevated box just west of the eastern group of platforms, who can be directed when necessary by signals from the despatcher's box. The despatcher has two assistants, one of whom keeps a time record of all trains entering and leaving the terminal and receives and transmits by telephone and telegraph messages to and from all parts of the terminal and the entire elevated system in Brooklyn. The second assistant operates, under the despatcher's direction, switches controlling the train announcers and gate signals on the terminal platforms.

An illuminated track model is mounted in a vertical frame before the despatcher's eyes and shows automatically the position and movement of all elevated trains on the bridge. This train indicator is similar to the one used for subway trains in the East River tunnel, New York City, which was described in Engineering News, June 11, 1908, p. 630.

All trains carry distinguishing lights on their front and rear cars (two red lights for Ridgewood trains, etc.), but it was found to be desirable that the despatcher have earlier intelligence of the identity of approaching trains. As a train approaches from the Brooklyn end of the bridge, therefore, it is observed by a man stationed in a small box on the elevated track level a short distance west of the Manhattan tower. A circular disk in the observation box has nine divisions around its circumference, corresponding to the nine different elevated lines operating trains across the bridge, and a radial switch handle pivoted at the disk's center. The observer simply moves the handle around to the position marked with two spots colored the same as the lights on the head of the train. A similar dial in the despatcher's box has a pointer which follows the motion of the observer's handle. Besides pointing to the color sign of the approaching train, the pointer rings a bell—one stroke for each dial division passed over—so that the despatcher's attention is surely attracted to the indication before it is released.

This dial signal gives the despatcher the few seconds necessary to arrange for the disposition of the train in the terminal before it reaches the switch at the terminal entrance. A train switched in on the "red line" track (a name dating back to the old cable car days and having no present significance) can be put only into the north pocket. This means that Ridgewood trains must come in on the "red line" track, while Brighton Beach and West End trains must come in on the "white line" track so as to be passed in and out of the south pocket. The three island platforms, at which passengers can be loaded from either edge, can be reached by trains from both pockets and therefore give a certain amount of flexibility to the system. At the same time, however, an element of uncertainty is introduced in that passengers waiting on the island platforms must be prepared to take the train at either side. Advance notice is given at the island platforms by electrical announcers controlled by switches in the despatcher's box

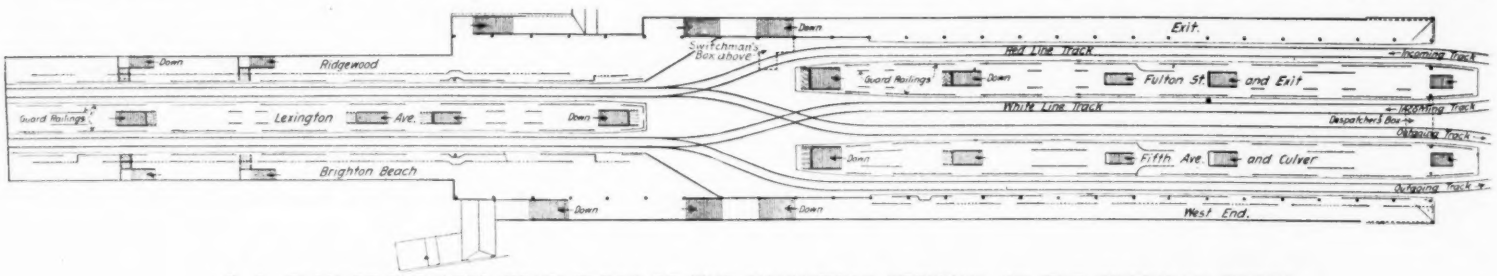


FIG. 1. PLAN OF ELEVATED TRAIN FLOOR OF THE MANHATTAN TERMINAL OF THE BROOKLYN BRIDGE.

The announcers resemble in principle those used at telephone switch boards and indicate both the identity of the approaching train and the side of the platform to which it will be switched. The announcer signal can be given by the despatcher immediately after he gets the dial signal from the observer out on the bridge, which gives time for the platform men to arrange the crowds for boarding the train on the proper side.

The elevated trains are equipped with folding platform gates operated by the guards. One guard is stationed between each two cars and operates the gates of both the adjoining platforms. The guard opens the gates as soon as the train comes to a complete stop at its proper platform, and he must be sure to close both gates before passing on the go-ahead bell signal to the motorman. Blue incandescent lights are suspended at a height of about 7 ft. above the station platform at distances apart equal to one car length, so that one light comes opposite each pair of car platforms within sight of the guard, and the lighting up of these blue bulbs (controlled by the despatcher's assistant) is the signal to close the gates. The go-ahead bell is then quickly passed and generally reaches the motorman just as the despatcher's gong rings out to give him the right of way.

The spacing of the trains bound in both directions on the bridge is regulated by a moving block signal system which permits the trains to follow each other without unnecessary or long stops. The signal lights are spaced only 100 ft. apart and remain at "danger" (red) for a distance of 700 ft. back from the last car of each train. The train speed on the bridge is limited to 15 mi. per hr.

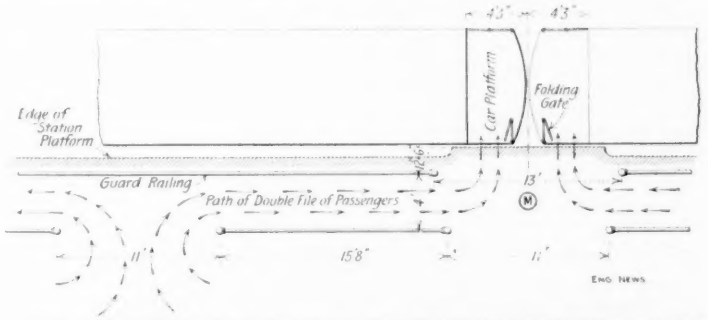


FIG. 2. DIAGRAM OF A TYPICAL SET OF GUARD RAILINGS ON ELEVATED RAILWAY PLATFORM IN THE MANHATTAN TERMINAL, BROOKLYN BRIDGE.

(All railings are of 2-in. iron pipe. Height of top rail above floor, 4 ft.)

STATISTICS OF SURFACE AND ELEVATED RY. PASSENGERS CROSSING BROOKLYN BRIDGE.

	Per day			Per hr., 5.30 to 6.30 p. m.		
	Elevated.	Surface.	Both.	Elevated.	Surface.	Both.
Passengers to Manhattan	107,139	52,206	159,345	3,258	2,135	5,393
Passengers to Brooklyn	96,205	57,449	153,654	31,515	14,039	45,554
Total both ways	203,344	109,655	312,999	34,773	16,174	50,947

Note:—The figures given are for Nov. 16, 1909.

Passenger Handling.

In one hour during the period from 5 o'clock to 6.30 in the evening, between 31,000 and 32,000 passengers must be loaded into 61 six-car trains in the Manhattan terminal. The seating capacity of each car is from 48 to 60 and the average number of passengers per car is from 85 to

88. As a matter of fact, owing to irregularities in the flow of passengers and trains, many cars go out loaded with 130 to 150 passengers. Each train has about three minutes in which to pass completely through the terminal, which gives about 30 or 40 seconds for loading.

The system of guard railings on the platforms of the terminal, designed by the Department of Bridges, New York City, is probably the most important single factor in the orderly handling of passengers. A plan of a typical set of railings is shown in Fig. 2, and the position of all railings is indicated in Fig. 1. Different railings are required at each station platform to fit in with the column and stairway positions. The passengers arrange themselves in a double file between the railings so that at each loading point the heads of two double files of passengers are drawn up facing each other with a space of about 6 ft. between the front pair of each file. A single platform-man stationed in this open space is enough to keep the files in order, prevent roughness and assist the guard in closing the gates. Policemen help to stop the movement of the crowd when the blue gate signals are lit. The railings do not reduce the available space for waiting passengers except for the small space kept open at each loading point.

The open space permits the rapid discharge of passengers at the platform which is used both for loading and unloading, and also facilitates the cross manœuvering sometimes necessary on the island platforms. At the Lexington Ave. platform between the two pockets, for example, Lexington express trains are ordinarily brought in on the north side and Lexington locals on the south side, and the passengers arrange themselves accordingly. Occasionally it happens that a local has to be run into the north pocket or an express into the south. Then the people waiting for that train file through between the same railings as though it were on the usual side, but at the loading point the files turn toward the opposite side of the platform and pass across and on into their train through the space kept open between the other two files.

The identity of the approaching train and the side of the platform to which it will come is made known to the waiting crowds some seconds in advance by announcing arms mounted in cases above the center of each island platform. The arms are manually operated by men stationed near the electrical announcers controlled by the despatcher's assistant. Illuminated signs are provided above each platform showing the name lights for the trains that load there. As a result, unnecessary crowding is practically eliminated, but when the right train arrives it finds its passengers all ready moving up for it with a good pressure on the files between the railings which makes the loading of a train a matter of only a few seconds.

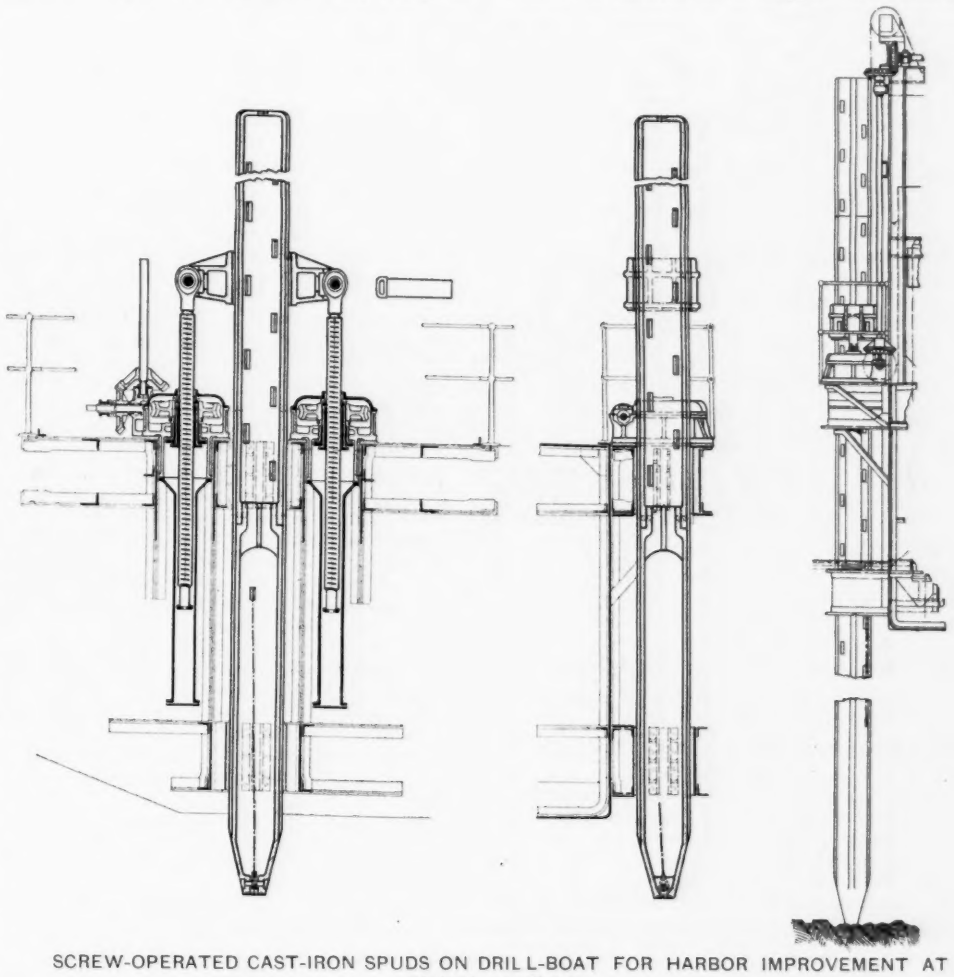
In case the loading platforms should become too densely crowded, as in the case of delayed trains, gates are provided at the foot of all stairways leading up from the mezzanine floor. The admission of passengers through the turnstile passimeters on the mezzanine floor, which have entirely replaced the old chopping boxes, can be stopped by telephoned orders from the platforms or despatcher's box. The Brooklyn yard at the east end of the bridge contributes largely to the successful operation of the Manhattan terminal. Trains of the nine different elevated lines are switched through this yard in the rush period at the rate of 122 per hour. Reserve trains, known as gap trains, are kept ready on three stub tracks in the yard during the rush hours and are sent across when required to fill gaps occasioned by delays or breakdowns on any of the lines in Brooklyn.

The terminal is at the present time just about up to the capacity of the bridge, that is, as many trains can be put through the terminal in a given time as can safely be operated over the bridge tracks. The East River tunnel of the Interborough subway has exerted a marked influence on the number of passengers using the elevated and surface lines on the bridge. The number crossing the bridge was about 97,000 per day less in each direction in November, 1909, than it was just before the opening of the subway tunnel in January, 1908. The principal decrease, however, is in the non-rush hours and more passengers are taken out of the terminal in the evening rush period at the present time than before the subway was opened.

A great deal of credit is due the engineers of the Department of Bridges of New York City for the development of the present efficient traffic system of the bridge, and their work has been greatly facilitated by the generous cooperation of the Brooklyn Rapid Transit Co. We are indebted for assistance in getting material for this article to Mr. F. Van Z. Lane, Assistant Engineer in charge of traffic, Department of Bridges, City of New York.

An Austrian Drill Boat with Screw-Operated Spuds.

Screw-operated cast-iron spuds are used on a rock drilling boat recently built for Austrian harbor improvement work at Triest by Bromovsky, Schulz & Sohr of Königgrätz, Austria. This scow is described briefly by Mr. C. Stromek, its designer, in the "Zeitschrift des Vereines deutscher Ingenieure" of March 26, 1910; the drawing herewith showing one of the four spuds is reproduced from that article.



SCREW-OPERATED CAST-IRON SPUDS ON DRILL-BOAT FOR HARBOR IMPROVEMENT AT TRIEST, AUSTRIA.

The boat is designed for work to a final depth of 33 ft., and was required to drill holes 6½ ft. deep, though as built it can drill 8 ft. with one steel. It is a steel vessel 50 ft. long by 20 ft. broad by 8 ft. deep. The spuds are located one at each corner, and are set vertical. There are two drill slides, both on the same side of the boat, carrying each a spring-cushioned percussion drill driven by a 3-HP. electric motor through a crank and pitman. The drill bit is about 3 ins. in diameter; the stroke of the pitman is 2.4 ins., and the limiting throw of the drill-rod 5½ ins. The normal speed of working is 380 blows per minute. The drilling machine has 8¼ ft. slide length on its guides, so that this depth of hole can be drilled without change of steel. The guide frame is pivoted to swing through a small angle both outward and lengthwise of the boat, to be able to drill several holes at one setting of the boat.

The spuds are cast-iron, hollow, of circular section with four longitudinal guide ribs. Each is made of several sections screwed together, and the upper sections are taken off when working in moderate depths. The guides are steel brackets attached to the outside of the hull.

For lifting the spud, a cable attached to the lower end and passing over a sheave at the top of the deck frame is handled by a hoisting-engine drum. For forcing the spud down, however, screw-jacks are provided as shown in the sketch. These are operated by a special engine, through a reversing clutch, shaft-and-gear connected to a set of worms meshing with worm-gear teeth cut on the nuts of the jacks. The two jack-screws of each spud carry a crosshead which slides loose on the spud but can be fixed to it by a steel wedge key driven through one of a series of rectangular holes in the spud.

In operating, the spud is held on the cable hoist until ready to be lowered when, if the bottom is suitable, it is dropped to a bearing. The great weight of the spud due to its being made of cast-iron ensures the point seating itself solidly. Then the jack crosshead is raised, keyed to the spud, and hauled down. The jack-screws of all four spuds being set in motion simultaneously, the boat is lifted evenly on the spuds.

THE PURCHASE OF COAL under specification fixing the quality and a method of payment according to the character of samples as delivered is urged by the Board of Managers of the Geological Survey of New Jersey on the purchasing agents of the various State institutions. The State Geologist has recently been directed to assist such purchasing agents in preparing suitable specifications and in making such analyses as are necessary to fix payment. The State expends about $125,000 annually for coal for some 15 institutions.

Some Formulas for Statically Indeterminate Members and Frames.

By C. T. MITCHELL.*

The following formulas are proposed as an aid in the analysis of moment stresses in single members or in rigid framed bents, due to eccentric loading or to the rigid framing, in statically indeterminate cases. Such cases are common enough in nearly all structures, and are either roughly allowed for or neglected in ordinary design, owing to the absence of formulas covering the subject. The writer is not aware of any publication which presents such formulas, simplified and arranged so as to be of use to the engineer.

No special originality is claimed in the deduction of the formulas, as they are all based on the accepted equation of the elastic curve. Though not mathematically exact, they claim to have all the exactness which the subject warrants, and in this connection criticism is invited.

Eccentrically-Loaded Column; Base Fixed, Top Hinged.

An eccentric load is treated in the text-books as a load applied parallel to the neutral axis of the column, so that the eccentricity is the same at the top and bottom of column. This causes a maximum deflection and stress at the middle of the column, and in order to determine it exactly we must resort to a differential equation containing y, the variable deflection, in the second term. There is another class of eccentric load, as shown in Fig. 1, where the column is fixed at the base, while its top is held against horizontal deflection only. Here the path of the resultant load passes through the axis of the column instead of being parallel to it. This is due to the action of the force R which prevents overturning of the column, and is just sufficient to cause the top of the column to remain stationary after the application of the load.

Since the moment is proportional to the distance of the dotted resultant from the axis of the column, it is apparent that the maximum moment is at the top of the column, where the deflection is zero, and that for appreciable values of the eccentricity a, the strength of the material will be exceeded at the top of the column before the moment at any other part will reach the value Pa. There will be a limiting value of P, which may be mathematically determined, beyond which, for very small values of a, the moment somewhere near the middle of the column will begin to exceed Pa in consequence of the deflection; but this refinement is unnecessary here. It is sufficient to state that P must approach the crippling load given by Euler's formula before this condition obtains.

To investigate the moment at any part of this column we must first find R. If the column is hinged at the base, the case is statically determinate and R is found directly. If it is fixed at the base, as shown in the figure, R becomes statically indeterminate, and resort must be had to the equation of the elastic curve. It is assumed that the moment of inertia, I, of the column, is constant, and that the horizontal deflection at the top of the column is zero. The origin is taken at the base, X-axis vertical, and Y-axis horizontal. Clockwise moments are taken as positive. Neglecting the effect of the added moment Py as being small, we have for the moment at any distance x from the base

$$M = E\,I\,\frac{d^2y}{dx^2} = -Pa + R\,(h - x)$$

whence

$$E\,I\,\frac{dy}{dx} = -Pax + Rhx - \frac{Rx^2}{2} + C_1$$

and

$$E\,I\,y = -\frac{Pax^2}{2} + \frac{Rhx^2}{2} - \frac{Rx^3}{6} + C_1x + C_2$$

As $\frac{dy}{dx}$ and $y = 0$ when $x = 0$, the constants are eliminated. As y also is zero when $x = h$, we have

$$-\frac{Pah^2}{2} + \frac{Rh^3}{3} = 0$$

whence

$$R = \frac{3}{2}\,\frac{Pa}{h} \qquad (1)$$

and the tangent at the top has a slope given by

$$E\,I\,\frac{dy}{dx} = -\frac{1}{4}\,Pah$$

or,

$$\text{tan of slope} = -\frac{Pah}{4\,E\,I} \qquad (1a)$$

Substituting the value of R in the equation for M, and letting $M = 0$, we have $x = \frac{1}{3}\,h$, which shows that the resultant load passes through the axis of the column at $\frac{1}{3}\,h$ from the base. There is a positive moment equal to $\frac{1}{2}\,Pa$ about the base of the column.

All points of contraflexure and hinged joints in this and subsequent figures are indicated by small circles; and for simplicity only the neutral axes of the members are drawn.

Combined Crane-and-Roof Column.

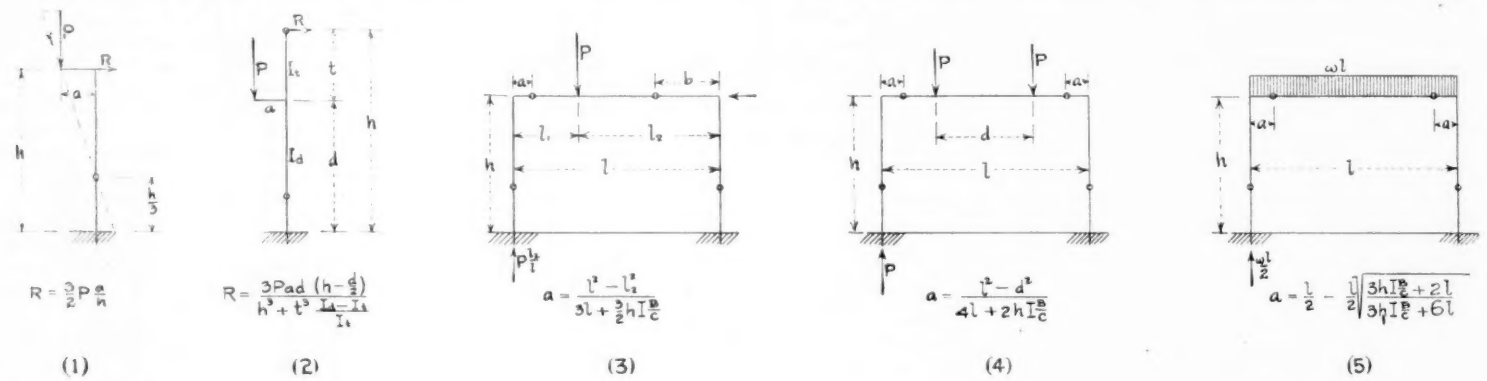
Fig. 2 is a more general case of eccentric loading. The top of the column is hinged and stationary, and the bottom fixed. The upper part of the column is assumed to have a different moment of inertia from the lower part, which is frequently the case in practice. The force R is determined the same as above, except that there is a separate integration to perform for each division of the column. The fact that the two deflection curves for d and t have a common tangent and displacement at their junction enables us to eliminate the constants.

In case there is an axial load on the top of the column, and the axes of the upper and lower divisions do not coincide, there will be an additional moment, which must be added to or subtracted from Pa, according as it is positive or negative. This case is analogous to that of a column supporting a crane-girder midway, and carrying the roof of the building at the top. The position of the zero point is variable for this case, but may be found as soon as R is known. The formula for a column with hinged top is presented, because it gives slightly greater moments than one for the top fixed, and is much simpler to apply, since the latter requires the determination of a couple at the top to fulfil the condition of a fixed end.

The formula for hinged top is

$$R = \frac{3\,Pa\,d\,(h - \frac{1}{2}\,d)}{h^3 + t^3\,\frac{I_d - I_t}{I_t}} \qquad (2)$$

It will be noted that the moments are less than Pa for every position of the load, in this


R = 3/2 P a/h
(1)
R = 3Pad(h − d/2) / (h³ + t³ (I_d − I_t)/I_t)
(2)
a = (l² − l₂²) / (3l + 3/2 h I_B/I_C)
(3)
a = (l² − d²) / (4l + 2h I_B/I_C)
(4)
a = l/2 − l/2 √((3hI_B/I_C + 2l)/(3hI_B/I_C + 6l))
(5)
Single Load
a = (l² − l₂²) / (3l + 3/2 C)
Uniform Load
a = l/2 − l/2 √((3C + 2l)/(3C + 6l))
C = h₁h₂I_B / (h₂I₁ + I_B h₁)
n₁ = I₁h₂ / (h₂I₁ + I_B h₁)
n₂ = 1 − n₁
(6)
Centre Load P
R = P(3l² − 4a²) / (2(3l² − 4a² − 12c²) + 4 h₂³/h₁³ (3ah + a²) I_B/I_C)
Uniform Load wl
R = ω(a³ − 2a²l + l³) / ((3l² − 4a² − 12c²) + 2 h₂³/h₁³ (3ah + a²) I_B/I_C)
(7)

FIGS. 1-7. SOME STATICALLY INDETERMINATE FRAMES.

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ase, except when $t = 0$, when the formula reduces to Case 1.

In case there is more than one load on the column, R is determined by an algebraic summation of the R's for each load, though in this case the formula only applies to a column of constant cross-section.

Frame of Two Columns and Cap Beam.

Fig. 3 is an application of the first case considered. It represents a beam of moment of inertia I_b, supported by and rigidly fixed to two like columns, each of moment of inertia I_c; the beam carrying a concentrated load at any position. The moments of inertia I_b and I_c are of course taken about axes perpendicular to the plane of the paper. The deflection of the beam under the load is resisted to a certain extent by each column, with the result that an inflection point is formed on each side of the load. It is evident that if we can locate these points, we can determine the moment on either column directly, since the effect is equivalent to that of a cantilever bridge with suspended span.

The following assumptions are made: (1) that the displacement at the top of either column is zero in any direction; (2) that the tangents to deflection curves at the intersection of beam and columns always form a right angle; and (3) that the entire structure possesses a uniform modulus of elasticity. The columns are taken as fixed at the base.

Take an origin at the right end of the beam, assume Y-axis vertical, X-axis horizontal, and clockwise moments positive. Call the left reaction R_1; the distance from the left column to zero point, a; and the other dimensions as shown in Fig. 3. The problem is to find an expression for the tangent to the curve at the left end of the beam, and equate it to an expression for the tangent to the curve at the top of the column, and thus solve for a.

We have for the moment at any point of l_2, at distance x from the right end:

$$M = E I_b \frac{d^2 y}{d x^2} = - P (l_2 - x) + R_1 (l - x) - R_1 a \qquad \text{(A)}$$

And for any point in the segment l_1 similarly:

$$M = E I_b \frac{d^2 y}{d x^2} = R_1 (l - x) - R_1 a \qquad \text{(B)}$$

Integrating eq. (A) gives:

$$E I_b \frac{d y}{d x} = - P l_2 x + \frac{1}{2} P x^2 + R_1 l x - \frac{1}{2} R_1 x^2 - R_1 a x + C_1$$

and

$$E I_b y = - \frac{1}{2} P l_2 x^2 + \frac{1}{6} P x^3 + \frac{1}{2} R_1 l x^2 - \frac{1}{6} R_1 x^3 - \frac{1}{2} R_1 a x^2 + C_1 x + C_2$$

As $y = 0$ when $x = 0$, $C_2 = 0$.

Integrating eq. (B) gives:

$$E I_b \frac{d y}{d x} = R_1 l x - \frac{1}{2} R x^2 - R_1 a x + C_3 \qquad \text{(C)}$$

and

$$E I_b y = \frac{1}{2} R_1 l x^2 - \frac{1}{6} R x^3 - \frac{1}{2} R_1 a x^2 + C_3 x + C_4$$

As $y = 0$ when $x = l$, and the two curves have a common tangent and deflection at the load, we have three conditons by which to determine the three unknown constants. Substituting the value of C_3 in eq. (C), we have for the tangent at the left end of the beam

$$E I_b \frac{d y}{d x} = \frac{R_1 l^2}{6} - \frac{R_1 a l}{2} - \frac{P l_2^2}{6 l}.$$

Now the tangent to the curve at the top of the column we find from the deduction for the column Fig. 1, eq. (1a), to be

$$E I_c \frac{d y}{d x} = \frac{R_1 a h}{4}$$

after changing the sign, since the moments are taken on the opposite side of the column. Equating these two expressions, and solving for a,

$$a = \frac{R_1 l^3 - P l_2^3}{R_1 l \left(3 l + \frac{3}{2} h I \frac{B}{C} \right)}, \text{ where } I \frac{B}{C} = \frac{I_b}{I_c}$$

It only remains to determine R_1. Assuming that $R_1 = \frac{P l_2}{l}$, the equation reduces to the form:

$$a = \frac{l^2 - l_2^2}{3 l + \frac{3}{2} h I \frac{B}{C}} \qquad (3)$$

If the load is at the center of the beam, it becomes

$$a = \frac{l^2}{4 l + 2 h I \frac{B}{C}} \qquad (3a)$$

On letting $h = 0$, which produces the condition of a beam with fixed ends, and comparing values of a for different positions of the load, with the values of a given in mechanics for a beam fixed at the ends, a slight discrepancy is found to exist for all positions of the load except at the center. Our assumption therefore that $R_1 = \frac{P l_2}{l}$ is only an approximation. For a beam fixed at the ends, with an unsymmetrically placed load, the moments are unequal at the opposite ends of the beam. As this condition will more or less exist in the structure under consideration, especially with short or heavy columns, the greater moment will prevail over the lesser, and, since in Fig. 1 the lateral force acting on the column is directly proportional to the top moment, there will be a slight deflection of the whole structure in the direction of the lesser moment, in order to restore equilibrium.

If the bent is allowed to find its own equilibrium, the two reactions will naturally be proportional to the divisions of the beam. But we have assumed that there is no deflection of the structure, in other words, we have introduced a force (such as would be supplied by diagonal sway bracing or other means) to prevent any deflection, and this force must exert a moment about the base of the structure, slightly changing the relation of the reactions. To determine R_1 exactly, we must first find an equation for b, similar to the one for a, except that l_2 becomes l_1 and R_1 becomes $(P - R_1)$; we then find another equation containing a, b and R_1 by equating the sum of the moments on either side of any point in the beam (the moment of the overturning force referred to thus becoming zero). Having three equations containing the three unknowns, a, b, and R_1, we can solve for R_1. The result contains third powers, and is so unwieldy as to be out of the question for practical use. The results it gives are very close to the assumption made, as the writer has proved to his own satisfaction.

When the load is at the center of the beam, the formula above given becomes exact, within the limitations imposed by the hypothesis and the further limitation that in computing the tangent to the column, we have considered only the deflection caused by the moment R_1 alone, and neglected any ultimate deflection due to the vertical load R_1 acting along the axis of the deflected column. Greater refinement would merely transform the formula into a curiosity, without appreciably affecting the results.*

In the case just considered, and all following ones, the columns have been assumed to be fixed at the base, as this is usually approximately the case in practice, and results in slightly greater bending moments on the column. To find a for hinged columns, simply multiply the term containing h by 4/3, since the tangent to the curve at the top of a column with hinged base, is 4/3 that of one with fixed base.

*As the deflection of the beam due to shear is also neglected, these two considerations will tend to neutralize each other.

If there are two or more loads on the beam, placed unsymmetrically about the center line, the moment on either column is found by taking the sum of the moments due to each load. If the loads are symmetrically placed, the moment is more conveniently found by means of the following formula:

$$a = \frac{l^2 - d^2}{4 l + 2 h I \frac{B}{C}} \qquad (4)$$

Since all these formulas apply equally well when the column shown is replaced by a tension member, this formula may be used in investigating the moment in vertical members of a through bridge, with rivet-connected floorbeams. In a through railway span known to the writer, where the moments of inertia of floorbeam and hip-vertical are as 40 to 1, the resulting eccentricity is found to be 1¼ ins. This, in connection with the maximum load on the floorbeam, including impact, gives a bending stress of 2,400 lbs. per sq. in. on the inner flange of the vertical. As the latter was designed for a direct net stress of 16,000 lbs. per sq. in., the probable maximum stress was 18,000 lbs. per sq. in. If the floorbeam had been designed with less regard for stiffness, the resulting bending stress in the vertical might well have been considerably higher. The use of this formula thus enables one to find, with a minimum of labor, the proper proportions of beam and vertical, in cases where economy of headroom is an important factor.

Fig. 5 shows the same class of structure with a uniform load wl. As the loading is symmetrical, no approximation is introduced in the deduction. For convenience the origin is taken at the center of the beam, where the tangent to the deflection curve is zero. For the moment at any point of the beam at the distance x to the left of the origin, we have

$$M = E I_b \frac{d^2 y}{d x^2} = - \frac{w}{2} \left(\frac{l}{2} - x \right)^2 + \frac{w l}{2} \left(\frac{l}{2} - x \right) - w a \left(\frac{l}{2} - \frac{a}{2} \right)$$

Integrating

$$E I_b \frac{d y}{d x} = - \frac{w l^2 x}{8} + \frac{w l x^2}{4} - \frac{w x^3}{6} + \frac{w l^2 x}{4} - \frac{w l x^2}{4} - \frac{w a l x}{2} + \frac{w a^2 x}{2}$$

Substituting $\frac{l}{2}$ for x, the tangent at the left end of the beam

$$= E I_b \frac{d y}{d x} = \frac{w l^3}{24} - \frac{w a l^2}{4} + \frac{w a^2 l}{4}$$

Now the tangent to the curve at the top of the column we know from above to be

$$\frac{P a h}{4 E I_c}$$

But P is assumed to be the equivalent load which acts at the inflection point, and in this case is $\frac{w}{2} (l - a)$. Substituting this value of P, equating the two tangents and solving for a, results in the expression:

$$a = \frac{l}{2} - \frac{l}{2} \sqrt{\frac{2 l + 3 h I \frac{B}{C}}{6 l + 3 h I \frac{B}{C}}} \qquad (5)$$

The bending moment on the column then is, roughly, $wa \frac{l}{2}$ or, if the value of a is large, $\frac{wa}{2} (l - a)$. By letting $h = 0$, a is found to be $\frac{l}{2} - \frac{l}{2\sqrt{3}}$, which is the value of a for a beam with fixed ends, under uniform load.

General Case of Two-Story Framed Bent.

There will now be deduced the two general formulas next shown, which cover not only the three preceding cases but also the case of a beam rigidly affixed to *two* members at each end, provided the arrangement is symmetrical about the center of the beam, and the three members intersect in a point. The supporting members may have any direction whatever, provided the conditions are such that there is no displacement of the point of intersection, such as would be assured when one of the members was a vertical tension or compression member. If there is any displacement of the point of intersection, secondary bending moments are induced, which the formulas do not provide for.

In any one of the bents sketched in Fig. 6, imagine a force R_1 at the end of the lever-arm a, acting on the supporting members, the intermediate part of the beam being temporarily removed. The resulting moment $R_1 a$ will be resisted in this case by two members instead of one. Call n_1 the proportion of $R_1 a$ resisted by member h_1, and n_2 the proportion resisted by member h_2. We have the condition then that $n_1 + n_2 = 1$. To find another equation containing n_1 and n_2, we equate the tangents to the deflection curves of the two members at their intersection. Since there is assumed to be no displacement at this point, and since we will assume the other ends of the members to be fixed, it is evident that the required expression for the tangent is the same as that deduced for the column Fig. 1, in eq. (1a), or $\frac{Pah}{4EI}$. Substituting the proper values of P, h and I, and equating the two expressions, we have

$$\frac{n_1 R_1 a\, h_1}{4\,E\,I_1} = \frac{n_2 R_1\, a\, h_2}{4\,E\,I_2}$$

Solving for n_1 and n_2

$$n_1 = \frac{h_2 I_1}{h_2 I_1 + I_2 h_1}, \text{ and } n_2 = 1 - n_1 \qquad (6a)$$

Either of these expressions, multiplied by $R_1\ a$, will give the moment on the corresponding member. This case, however, must not be confused with the case shown by Fig. 2, for in the latter the column is free to deflect either way at the point where the lever arm a intersects its axis, while in the present case we have assumed some force acting at this point to prevent deflection. In the sketches in Fig. 6, the beam itself supplies the force, and it only remains to find the unknown quantity a to make the analysis complete. Since the connection between beam and supporting members is rigid, the tangents to the deflection curves will be equal at the point of intersection. The tangent to either supporting member, after substituting the value of n_1, is

$$\frac{h_1\, h_2\, R_1\, a}{4\,E(h_2\, I_1 + I_2\, h_1)}$$

where $R_1 = \frac{Pl_2}{l}$ or $\frac{w}{2}(l - a)$, according to the loading. Equations for the tangents to the beam have already been deduced for concentrated and uniform loads, and the final expressions for a as shown are obtained in the same manner as in the previous problems. They are:

For a concentrated load,

$$a = \frac{l^2 - l_2^2}{3\,l + \frac{3}{2}C} \qquad (6b)$$

For uniformly distributed load,

$$a = \frac{l}{2} - \frac{l}{2}\sqrt{\frac{3\,C + 2\,l}{3\,C + 6\,l}} \qquad (6c)$$

in which

$$C = \frac{h_1\, h_2\, I_b}{h_2\, I_1 + h_1\, I_2}$$

It will be observed that the same approximation for the reactions of a single load in any position on the beam is introduced here as for the simpler case. By letting I_1 or I_2 = zero, it will be found that these formulas reduce to the preceding ones. Also, as before, if either member is hinged at the end, multiply h for that member by 4/3.

In general, when rigid frames of this kind are designed solely to support the load on the beam it will be found that the beam section will be so much greater than the column section that a will be very small, and the moment stress on the column negligible. In other words, the column will have to be designed to satisfy the conventional formulas for column design, rather than with reference to the moment induced by the beam. With short columns, however, or heavy, shallow girders, cases occur where the total stress at the top of the column will exceed the accepted safe limit. For such cases, the connecting gusset plates, if carried far enough down the column, will usually prove sufficient reinforcement, since the moment stress decreases from the top of the column down.

The most important application of the formulas is the case where the column or other supporting member carries an initial axial load, in addition to the load on the beam. In such cases it will sometimes pay to avoid a rigid connection, simply letting the beam rest on brackets, since the eccentricity by this means is less than where the connection is rigid. In general, where light beams, not forming an integral part of the whole structure, are attached to heavy columns, rigid connections are inadvisable, not only on account of the strain on the column, but also on account of the excessive strain on the connecting rivets, since the beam is in effect a cantilever from the column out to the inflection point, carrying half the load at its end. Investigation of all such cases is easily effected by means of the formulas. An illustration will be given:

Two adjacent Z-bar columns, 16 ft. high and 16 ft. apart on centers, stand with the projecting flanges of the Z-bars pointing toward each other. They have fixed bases and fixed tops, due to symmetrical girder loading. The moment of inertia of each column about the axis in question is 200, its area of section is 17 sq. ins., its total depth is 12⅝ ins., and it carries an axial load of 170,000 lbs. It is proposed to support a chain block midway between the columns for the purpose of lifting weights up to 20,000 lbs. As the girder above is fully loaded, two 15-in. channels, with a combined moment of inertia of 625, will be directly riveted to the flanges of the columns 3 ft. from the top, to support the block. As the weights to be lifted only increase the direct unit stress in the columns by about 600 lbs. per sq. in., this may be considered safe. To find the moment stress consult eq (6b). In this case, $h_1 = 13$, $h_2 = 3$, $I_b = 625$, $I_1 = I_2 = 200$, and $l = 16$. Substituting these values, a is found to be 3¼ ft., or 39 ins. The moment will then be $10{,}000 \times 39 = 390{,}000$ in.-lbs. The proportion of this moment borne by the upper part of the column, or n_2, by eq. (6a), is $\frac{13_m}{16}$, or 320,000 in.-lbs. The resulting stress on the extreme fiber of the column will accordingly be about 10,000 lbs. per sq. in., which added to the direct stress makes a total of 20,600 lbs. per sq. in., which is beyond the safe limit for a column of medium steel, especially as there is a probability of the direct stress at this point in the column being greater than the amount assigned, due to deflection. By riveting brackets to the columns, and merely resting the channels thereon, it is seen that an excessive bending moment is avoided.

Kneebraced Bent.

In Fig. 7 the case of a kneebraced beam and column connection is represented. All the connections are assumed to be hinged except the bases of the columns, which are fixed. As it is impossible to use the method of tangents in this case, expressions for the deflection of the beam and column at the connections of the kneebraces are found and equated, solving for R, the vertical and horizontal component of the force exerted by the brace. As the kneebrace is assumed to make an angle of 45° with the horizontal, the deflections and components will be practically equal.

Resulting formulas are:

For a central concentrated load P,

$$R = \frac{P(3\,l^2 - 4\,a^2)}{2(3\,l^2 - 4\,a^2 - 12\,c^2) + 4\frac{b^3}{h^3}(3\,a\,h + a^2)\,I\frac{B}{C}} \qquad (7a)$$

For uniformly distributed load wl,

$$R = \frac{w\,(a^3 - 2\,a^2\,l + l^3)}{(3\,l^2 - 4\,a^2 - 12\,c^2) + 2\frac{b^3}{h^3}(3\,a\,h + a^2)\,I\frac{B}{C}} \qquad (7b)$$

Having R, the column may be considered as a beam with one end fixed and the other free, and the bending moments computed accordingly. A partial check on the formulas may be obtained by letting I_c equal infinity, when the values of R will be found to correspond to the reactions of a continuous beam as given by the Theorem of Three Moments.

Formulas might be multiplied without number to suit the various cases of this character that arise in structural work. It is thought, however, that a judicious use of the ones given in this article will cover practically all cases which it is necessary to investigate.

Though the formulas only apply to symmetrical arrangement of structure, accurate enough results may be found for the contrary as follows: Suppose the beam to be fixed in a wall at one end and riveted to a column at the other. Find a for the column end, on the assumption that the structure is symmetrical. Do likewise for the other end, by letting I_c equal infinity. Having the two zero points, it is a simple matter to find the reaction at the column and consequent moment. This method may be carried out for any unsymmetrical arrangement, and gives results close enough for all practical purposes.

Though these formulas will not come in for very general use, and are valuable more as a means of testing completed designs than as working formulas, the writer believes that they will be considered a useful acquisition by most structural designers. On this supposition the above article was prepared for publication.

Field Work in Locating Irrigation Ditch and Canal Lines.

By ALBERT B. BARTLETT,* M. Am. Inst. Min. Engrs.

The history of irrigation in the west shows that the most economical irrigation enterprises were those first taken up, the conditions being such that only ditch lines from streams with perpetual flow during the irrigating season (from May to September) were necessary to irrigate the crops. In such cases, the area of land available generally exceeded what was thought to be the irrigating capacity of the streams, and therefore the ditch lines selected were those which could be constructed at the least possible cost, to carry the volume of water desired. Later on, measurements made on the streams showed that the volume of water flowing in the streams during the spring months was greatly in excess of that available during the dry season in the summer, when water was required for irrigation. Storage of water was the next step. Following storage and the increased values which irrigated lands were found to have, the more expensive canal lines were constructed, and it seems to be the case with the western streams which rise in mountainous countries, that extensions of the irrigating systems have unlimited possibilities.

The first ditches were run over such ground as to avoid heavy cuts, steep sidehill work, flumes and tunnels, which are not now regarded as very objectionable features. In order to get the greatest possible carrying capacity for the ditches the grades were made too heavy, so that much erosion and wearing down of the bottom of the

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itches occurred, making it necessary to conruct drops at many points along the line. In me cases, entirely new ditch lines were run on ghter gradients, irrigating more land (without e former trouble and maintenance) from the me headgates.

As a result of experience along these lines, the esign of irrigating systems is now a matter of uch careful preliminary engineering, and the esults are much more satisfactory and certain. he first step consists of getting the state and overnment maps of the region in which an irriating system is contemplated, also any availble records of the rating of streams. The local onditions and topography are then looked over n the field with a hand level, and then tentative ditch grades are run with a light level or transit, to find out where ditch lines will go, and the haracter of the country through which they will ave to be constructed to cover the desired area f land. Local conditions govern the method used in carrying on the work after the first step, as it often happens that the height of the grade of the canal is limited by the elevation of the outlet of the storage reservoir which will hold water for the system. Very often, a range of hilly country occurs at the upper edge of some large tract of irrigable land and it is more desirable to build the ditch at the lower edge of such a range. When there is much choice in locations for canal lines, it is customary to take topography along all these locations, above and below them, and from this topography, in the office, the most desirable line is selected by estimating from the topography the amount and classification of the material to be moved and the land to be irrigated under it.

The method of taking the topography varies with each special case, but generally consists in running one grade line with a large wye-level, following this with a transit, taking the topography by stadia, by vertical angles. Reductions are made with a slide rule, and the topography plotted in contours of 1 ft., 2 ft. and sometimes 5 ft. intervals. The methods used in surveying a ditch for construction, after its location has been determined upon, vary with each special case, and according to the size of the proposed ditch. In the case of very small ditches, designed to irrigate 100 or 200 acres, and where the person who is constructing the ditch does not expect to have the work done by a contractor, the survey necessary requires only the setting of stakes on the lower side of the ditch, center stakes and upper slope stakes being unnecessary. There are thousands of ditches of this kind in Wyoming, taking water from small streams. The engineering features are very simple, as the work has sometimes been done by the ranchmen themselves, with a carpenter's level or crude leveling instrument. With such small ditches, the flow was generally in excess of that which would cause washouts in the ditch, but on account of the small size, the maintainance was generally an easy matter. Later, however, state laws required that each ditch must have filed in the office of the State Engineer a map showing its exact location with respect to the lines of the public surveys, the meander of streams, and the number of acres to be irrigated in each 40-acre tract. These requirements have made it necessary that competent engineers do the surveying work, which has resulted in the ditches being built to more satisfactory grade lines.

In making these surveys, a transit with an attached level bubble of about 20 secs. rating, and a solar attachment, is used to carry both line and levels, the rodman pacing off each 100 ft. and setting stakes on the grade of the lower side of the ditch. All sinuosities in the ditch line and the topographic features are located by stadia measurements, ties being made to all section corners. Using this method, it is necessary to go over the ditch line only once to get all necessary data. It is common practice for the irrigator to run a plow furrow along the line of the ditch stakes so that if the latter are destroyed, the location of the grade is not lost.

In the case of larger ditches, those from 5 ft. to 10 ft. on the bottom, and a depth of 1 to 3 ft., the field work necessary in locating the ditch upon the ground generally consists of cross-sectioning the ditch on the first survey, after the location has been decided upon, the alinement of the ditch being done by eye. The slope stakes on the lower side of the ditch are set first for about 1,500 ft., after which they are lined up by eye to tangents and curves nearly conforming to the contour which the slope stake on the lower side of the ditch would naturally follow, but improving on this alinement by increasing or decreasing the cut in order to have good curves and tangents. After thus running the uitch, the upper slope stakes are set by the ordinary methods used in cross-sectioning. No center stakes are set, however, as the country is generally so uniform that a two-level section is sufficiently accurate. Bench marks are set about every 1,500 ft. along the line and 100 ft. on either side.

After the cross-section work is finished, the alinement is run by transit, generally being carried along the lower side of the ditch, and ties are made at the intersection of all section lines by getting a true course and distance between the two corners on each side of the line at each intersection. The bench marks are also located from this line. The 100-ft. tape is generally used for making measurements on cross-section work and transit line, and the courses are taken either by deflection, as is done in the case of railway surveys, or else by courses referring to the true meridian determined by the solar attachment at each set up. As the curves are only run in by eye, they are not located exactly, but the transit line is not permitted to miss any stake over 10 ft.

In work of this kind, the solar attachment, either the Smith or the Saegmuller with an hour circle and latitude level, presents the most satisfactory means of carrying forward ditch lines, where reference stakes can be set within each half-mile, because with a little practice the solar instrument can be set up and the meridian determined with probable accuracy of 1 min. or 1½ mins., in much quicker time than it is possible to set up over a point and sight on the back sight. At the same time, a rear flagman is not required. The percentage of cloudy days in the west is so low that there is hardly ever any inconvenience caused by having to wait for the sun to come out from behind a cloud, and in case of a continuance of cloudy days, the deflection method may be used.

For ditches over 10 to 12 ft. wide on the bottom, unless the country is rough, requiring sharp curves (the radius of which should never be less than six times the top width of the canal), the regular methods of railway location and cross-sectioning are followed. Reference stakes are set at each side of the line at the end of each tangent, and the ditch cross-sectioned with a three-level section; or, if the canal line requires it, with a five-level section. In such case, the transit lines are carried on and perpetuated in exactly the same manner as that used for railway lines.

In selecting locations of laterals, on the larger projects, for the carrying of water from the main canals to the different tracts of land to be irrigated, the methods used are practically the same as for locating canals. Usually a topographic survey of all the land to be irrigated is necessary in order to show the most satisfactory and economical courses for the laterals to follow, as the contracts which the Carey Act companies are required to make with the respective states in which they operate require that water must be delivered to each 160-acre tract, after which it is handled by the irrigator.

In designing canals, having given the discharge in cubic feet of water per second of time, either Kutter's formula is employed or graphic tables derived from this formula, using $n = 0.03$ or 0.025 (the constants for clean ditches in ordinary earth).

In order to make the construction desirable to contractors, the lower side of the ditch is generally designed to have a slope of from 1 on 1½ to 1 on 3 in excavation, depending upon the firmness of the material, and from 1 on 2 to 1 on 4 for fill on the lower bank. It almost universally happens that canals are built on a slightly sloping sidehill, so that the cut is from 1 ft. to sometimes as much as 20 or 30 ft. greater on the upper side than on the lower; therefore the cut on the upper side of the ditch is made from 1 on 1 to 1 on 2, again depending upon the firmness of the material. This, of course, is for earth. For solid rock or loose rock, the side slopes are always made steeper. On account of the soil being generally shallow, and to avoid shale and loose rock classification, the canals are made to a greater width than would be used if the most economical cross-section based upon the wetted perimeter were selected.

The greatest velocities permissible in different classes of material are as follows:

	Velocity, ft. per sec.
Sandy soil	1.3
Loose gravelly soil	2.5
Firm soil and firm sandy loam	3.0
Gravel	3.6
Firm gravelly soil	5.3
Loose rock and shale	6.0 to 7.0
Solid rock	7.0 to 15.0

Precautions for the Safety of Employes in Plants of the United States Steel Corporation.*

Prior to 1906, the work of preventing accidents in the plants of the United States Steel Corporation had been looked after by the casualty departments of the various subsidiary companies. In 1907 the chairman of the American Museum of Safety was a guest at the annual dinner of the Corporation, and offered suggestions for safety devices. Within another year the Corporation had organized a Committee of Safety, composed of representatives from the various companies, but acting independently of the casualty departments, its object being the inspection of all the plants, with reference to the prevention of accidents. It also serves as a clearing-house for obtaining and disseminating the best information on this subject.

The Committee sends its safety inspectors to examine the mills and plants. These are men of experience in matters connected with accidents and are able to detect even slight sources of danger. Nothing is considered too trivial to escape attention—unwashed windows, which should be cleaned to admit sufficient light, worn floors, loose boards, material piled carelessly and liable to topple over.

The recommendations of the inspectors are sent to the Committee of Safety, which, in turn, sends them to the proper representative of the plant which has been inspected. The company is allowed 30 days in which to consider and act upon the recommendation. If it is not adopted, a return must be made, giving good reason for the objection to the recommendation. At the next meeting of the Committee, these returns are discussed in detail and, where objection has been made, if the reasons given are not convincing to the Committee, the representative of the company concerned is requested to appear and explain the matter in person.

The Committee is at present standardizing safety appliances for machinery common to all plants. Where formerly methods for safeguarding machines and danger points were worked out independently, now when a device is found practical in one mill efforts are made to introduce it into the other mills.

The Corporation realizes how very important it is to provide for safety from the start, at the time when the machine is built, and when the safe-guarding is least inconvenient and least expensive. When plans are drawn for the construction of new machinery, or the rebuilding of old, whether built by the company or ordered outside, to each drawing must be affixed a label on which are listed the various classes of safety devices and safety provisions made. Before the purchasing department accepts the drawing, it must have the label affixed, with each item checked up and signed by the draftsman who was appointed to consider the safety features. The subsidiary concerns, also, still do all in their power to promote general safety. For instance, in the drafting room of one of the companies the following notice is posted on the walls:

> Attention, Draftsmen: Take the necessary time and see that every drawing you make fully provides for the safety of the employe.

Another method employed in arousing the interest of employes in the subject of safety, was a foremen's prize contest held by one of the companies, which offered a series of prizes, the first of $25, for the best answers to the question: "What can foremen do that would probably lessen the number of accidents to our

*Extracts from a "Safety Bulletin" of the American Museum of Safety, 29 West 39th St., New York City.

employes?" A suggestion box is still another means of arousing interest. Employes are invited to drop in their suggestions and recommendations and practical suggestions are always rewarded.

One company prints upon the pay envelopes of the employes short suggestions and comments on the subject of accident prevention, with a view to increasing caution and watchfulness on the part of the men. The reproduction of a hand pointing out these sentences serves to excite the curiosity of foreign workers, who usually get someone to translate them. For the benefit of foreigners, safety signs, printed in several languages, are posted throughout the mills and yards of this company calling attention to points of danger. To meet the difficulty arising from the fact that many foreigners cannot read in their own language even, lurid

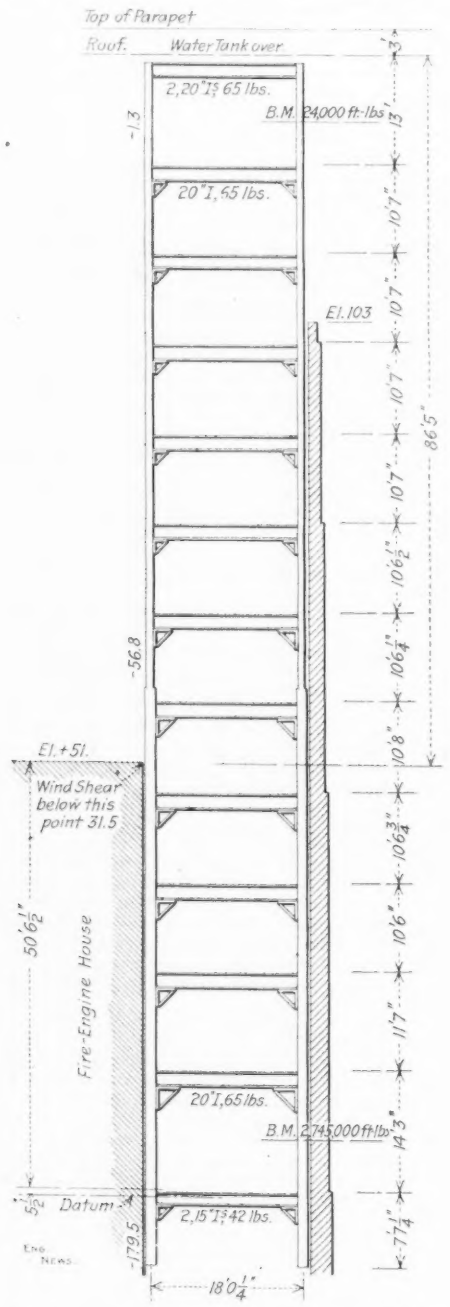

Fig. 1. Cross-Section of Twelve-Story Building at 20 East 12th St., New York City.

and graphic signs displaying a skull and cross bones, are used to convey the notice of danger and the necessity for caution.

In the matter of compensation for injuries, the Corporation follows the plan of letting the condition of the worker determine the amount and method. As a consequence, 99½% of all accident cases last year were settled without litigation. Of the million dollars spent by the Corporation in 1909 in compensation, only $40,000 was the result of lawsuits or obtained through lawyers. In some of the companies there was practically no resort to law. Since the safety inspections have been instituted, and up to Jan. 1, more than 5,000 recommendations have been made to the Committee of Safety and over 90% have been adopted.

A Narrow Twelve-Story Building.

By JOHN S. BRANNE,* Assoc. M. Am. Soc. C. E.

The structure described in the following is unusual because of its proportions, being very narrow in comparison to its height. The plot on which it stands is only 22 ft. 3 ins. wide at one end and less than 20 ft. at the other. The owner desired a 12-story building to be erected on this area, and, the story heights being fixed by those of an adjoining building with which it was to connect, a height to roof of 134 ft. above curb was required. The foundation work was of some difficulty, requiring pneumatic caissons sunk to rock.

The new building, located at No. 20 East 12th St., and the old nine-story building at Nos. 16 and 18, are owned by the same party, and were planned and built to form virtually one building. The freight elevator in the old building serves both, its shaft extended above the roof in an enclosure to be carried up to a height of 7 ft. above the new roof so as to deliver freight to the new 10th, 11th and 12th floors. Passenger service is taken care of by one elevator in the old building terminating in a bulkhead above its roof, and one elevator in the new building running to full height. The new building has one

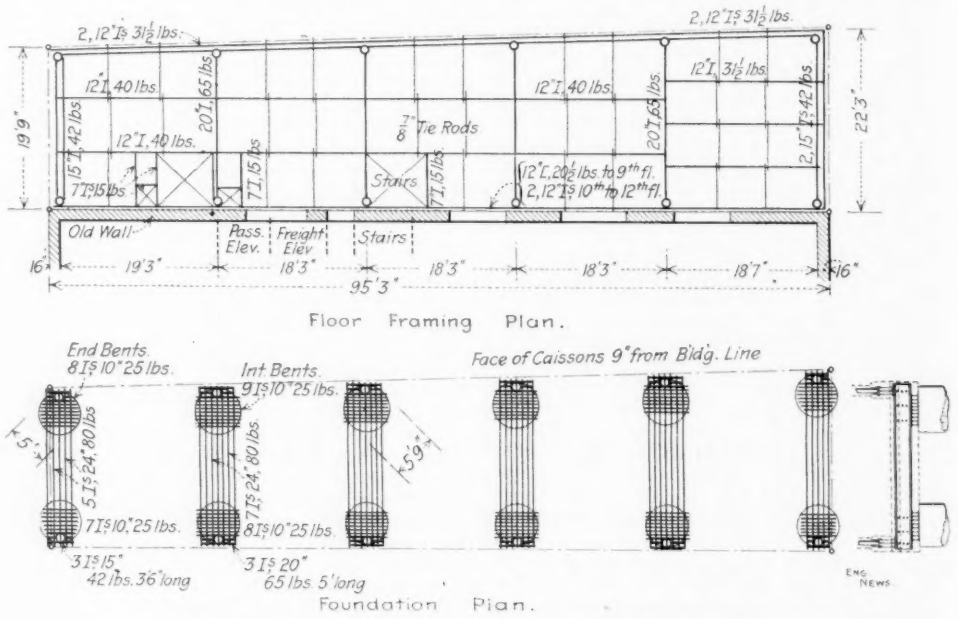

FIG. 2. FOUNDATION PLAN AND FLOOR FRAMING PLAN.

stairway up to the 9th floor; the three upper floors are served by an extension of the stairway in the old building in an enclosure alongside the freight-elevator extension and of the same height.

The east wall of the old building is pierced by door openings as shown on the plan in Fig. 2, providing access from either building to the elevators and stairways of the other. Thus the new building is in effect an extension of the old, and floorspace in both can be rented to the same tenant in the same way as though the building had been planned as one originally. The heating, ventilating, water and electric systems of the new building are worked more or less jointly with those of the old. The electric switchboard controlling both buildings is located in the old, and a connection is provided between the boiler plants of the two buildings.

The old building is of bearing-wall construction; its walls are founded on piles driven in the sand soil. On the east of the new building is a three-story brick fire-engine house, which has simple spread wall-footings. Before designing the foundations of the new building it was thought necessary to determine the underlying strata in detail. Three wash-borings were therefore made. They showed that the sand on top was underlain by a stratum of quicksand about 10 ft. thick, and that rock was reached at a depth of 24 ft. near the front of the lot and 30 ft. near the rear, depths measured from curb level.

Groundwater was reached at 11 ft. below curb level. The basement for the new building being fixed at 9 ft. 6½ ins. below the curb in the front portion up to a line halfway between columns 3 and 5, and at 8 ft. 6½ ins. for the balance, only 5 ft. is left between top of quicksand and basement floor.

Several methods of foundations were discussed, wooden piles, concrete piles, Clark piles, spread footings and concrete caissons, open or pneumatic. The objection to the wooden piles appeared to be the steady though slow recedence of the ground water level in this part of the city (probably due to the excavation of many deep cellars in the immediate vicinity, or to the construction of tunnels under the streets, as for instance the Subway) which would sooner or later leave the tops of the piles dry, causing deterioration of the pile tops and subsequent settlement of the superstructure; and also the risk to the neighbors' walls in driving piles practically on the lot line, through a treacherous, yielding soil. Anticipating trouble along these lines, a considerable amount of shoring would be required, and also underpinning if the attempt were made to cut off the piles at some distance below the present water-level. In the latter case some sheet piling would also be required to keep the quicksand away from the pile heads while placing the concrete mat. In any case cantilever beams would be required between two opposite wall columns to transmit their loads to the pile clusters, the centers of gravity of these not coming directly under the wall columns.

Concrete piles were open to similar objections as those noted for the wooden piles, excepting of course the objection referring to the decay following the recedence of the ground water.

Spread footings, meaning thereby a series of transverse beams laid directly on the soil, properly encased with a concrete mat so arranged as to transmit the loads of two opposite columns at a uniform pressure to the soil, were ruled out as this method of foundation would bring the cantilever (transverse) beams almost down on the quicksand, which would make it difficult to place the beams and afford a doubtful bearing even though the whole lot would be practically covered by a concrete mat; and with the probability of the recedence of the water level might cause uneven settlement, especially objectionable in a building 12 stories high with a base of only 19 ft.

It was decided to use either open or pneumatic caissons, going to rock. Although this method was more expensive than any of the others, yet it afforded safety in construction and subsequent absolute safety for the building, giving a positive support on the rock and eliminating uneven set

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ement. It was hoped that open caissons could used, being the less expensive of the two, but contractor found after going into the quick- nd about 4 ft. that it would be difficult and ngerous owing to the great fluidity of the quick- nd to proceed farther with the open caisson ethod, and air pressure was resorted to.

The diameters of the caissons are shown in ig. 2. There are 12 of them, having an average ngth of 14½ ft. The caisson contractor's plant rrived at the building on May 28, 1909, and the nking of the first caisson commenced on June The concreting of the last caisson was finished n July 1, 1909. In all there were 165 cu. yds. f concrete placed. The total number of working ours employed in the sinking of the caissons and lacing the concrete was 408 hours, or an average

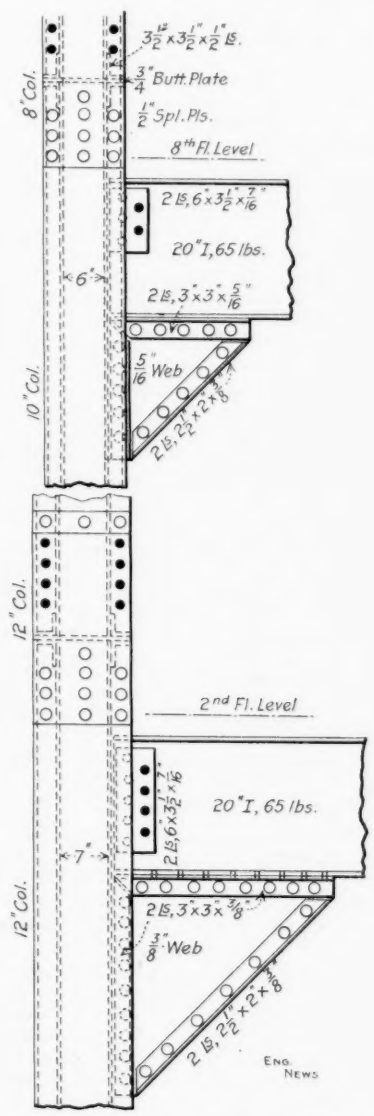

Fig. 3. Typical Beam Connections with Wind-Bracing Brackets.

time per foot of concrete caisson of 2⅜ hr.; per foot of shell penetration 1⅞ hr.

Only a slight amount of shoring was required, and this to secure against possible cracks forming in the walls of the fire engine house, this wall resting, as stated before, on a stepped-out footing course without pile supports.

The cantilever system employed is shown in Fig. 2. It consists of a series of 10-in. 25-lb. distributing beams on top of the concrete caissons, and 24-in. 80-lb. cantilever beams transversely, all beams being properly tied together with pipe separators and tie-rods, and all interstices filled with cement grout, with concrete casing all around for protection from rust.

SUPERSTRUCTURE.—The superstructure is of the ordinary type of skeleton steel construction with the enclosure walls carried by wall girders. On the west side of the new building the enclosure wall commences at the 10th floor level (or at the approximate roof level of the old building). The floor is of 12-in. hard-burned terra-cotta flat arches, topped off with cinder fill and 1¼-in. maple flooring. Stair and elevator enclosures are made of 4-in. terra-cotta blocks as are also the bulkhead enclosures around freight elevator and stairs above the roof of the old building and around passenger elevator above new building. The latter are covered outside with 8-ply plastic slate roofing. The roofs of all pent houses over stairs and elevators are formed by tees, 23-in. centers, filled with terra-cotta book tile 3 ins. thick. The roofing on main roof and pent houses is 10-ply plastic slate roofing.

WIND-BRACING.—Fig. 3 shows a typical connection between beams and columns, which forms a portal system of wind-bracing. Triangular plate gussets are riveted to the underside of the 20-in. transverse girders and to the columns. The webs of the girders are connected to the columns by 6 × 3½-in. angles, riveted. The bracing was designed for a wind load of 20 lbs. per sq. ft. on the east wall from roof down to the top of the fire-engine house. The wind shear was assumed to distribute equally between windward and leeward columns, and the points of contraflexure in the columns and beams were taken at midlength in each case.

This building was designed by Mr. Wm. C. Hazlett, Architect, 1133 Broadway, New York City. The writer was Structural Engineer. The foundation work was done by the O'Rourke Engineering Construction Co., and the steelwork by the Alfred E. Norton Co.

Comparison of the Characteristic Features of Special and Stock Hydraulic Turbines.

By H. BIRCHARD TAYLOR.*

There are two distinct classes of reaction turbines manufactured in the United States, namely, special or built-to-order turbines, and stock turbines.

We rarely find both classes of apparatus manufactured by the same concern. This is because the workmanship characteristic of the special turbine is of much higher grade than that required in the manufacture of the stock turbine, and the firms engaged in the construction of hydraulic machinery have found it impracticable to turn out two grades of workmanship in the same shop. Consequently, as a rule, a concern specializes in one or the other of the two classes, and does not attempt to manufacture both.

General Features.

A turbine developed especially for a particular combination of power, head and speed is more expensive and, as a rule, is far more efficient both hydraulically and mechanically than a stock turbine which would apply to the same conditions.

Stock turbines are made in lots from standard patterns, and for the conditions for which they have been intended, wheels so constructed have given entire satisfaction. As a class, stock turbines are distinctly a product of the testing flume and, although very high efficiencies have been secured in stock runners when tested at the flume, it is generally the case that the runners are applied to inefficient wheel-casings and draft tubes; consequently, the efficiency of stock turbines, in general, is low and flume tests cannot be depended upon as a reliable indication of the economy of the completed units when operating in place. The manufacturer of the stock turbine issues a catalog giving the powers, heads and speeds to which the apparatus he has in stock will apply, or for which he can make up machines in short order from his standard patterns.

This class of apparatus finds its application in cases where low first cost and quick delivery are the principal requisites, and where efficiency, cost of maintenance, regularity of operation and appearance are secondary considerations. The controlling factor in the purchases of hydraulic machinery for a majority of the small installations, has been and will be the one of first cost. There is a growing market for the stock turbine, and the manufacture of this grade of machinery has developed into an extensive and profitable business.

In a majority of cases where stock turbines will meet the specifications, the lowest bidder is awarded the contract.

The Influence of Development Cost.

The patterns constructed for a made-to-order turbine are seldom if ever used a second time, except for duplicate machines to be installed in the same power-house for which the original turbine was developed. Two installations rarely require wheels for exactly the same

Fig. 4. View of Steel Framework of Narrow Twelve-Story Building During Construction.
(Oct. 1, 1909; 11 stories erected.)

combination of the variables on which the design of a turbine depends, namely: power, head and speed. In the few instances where they are the same, very likely the local conditions governing one installation would call for a horizontal setting, while in the other a vertical setting would be required. Thus the patterns made for the units of one plant can seldom be utilized in the construction of units for another.

In cases where but one or two turbines represent the ultimate capacity of a station, the development charges—which include the drawing and pattern work—constitute a large percentage of the total cost of the hydraulic equipment. In offering a quotation on a made-to-order turbine,

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the manufacturer includes in his price the cost of developing the machinery especially for the conditions under which it will operate.

The manufacturer of the stock turbine proceeds in a different manner. If he finds that he has not in stock standard patterns which may be applied to the conditions, he figures on the construction of a new set. Knowing that most likely the new patterns will be utilized in the construction of many turbines for similar installations, the manufacturer does not include in his quotation the cost of the drawing and pattern work, but charges it to his plant.

Efficiency Guarantees and Tests.

In applying to a power-house a stock turbine which was originally developed for another having similar characteristics, the manufacturer usually runs some risk in making high guarantees of efficiency and operation. In some instances the purchaser never questions the efficiency, provided the turbine gives the guaranteed power, while in other cases the local conditions do not permit of a practical method for measuring the rate of the flow of water, and the purchaser accepts the flume tests of the runner without question. A large proportion of stock turbines, especially those set in open flumes, are not tested for efficiency, consequently the advertised efficiencies are those secured in the flume tests made on the runners and, therefore, they cannot be accepted as the true efficiencies of the turbines in which these runners are installed.

How Stock Wheels May Be Adapted.

Let us assume that bids are requested for a turbine wheel to have a capacity to deliver at its flange coupling 1,000 HP. when operating under a head of 40 ft. at a speed of 275 r. p. m., and for these conditions of power, head and speed the bidder is required to guarantee an efficiency of at least 80%.

In making his estimate for a machine to meet these conditions, the builder of special turbines will prepare a proposal drawing, from which the weights are calculated. The cost of complete detail drawings and a full set of patterns is then estimated, and to this is added the cost of the material and machine work. The operating expense and profit are then added and the final sum is the price quoted.

The stock turbine builder, in making his estimate, looks over his stock for a machine which will come nearest to the requirements. He finds, for example, that he has a set of castings which are duplicates of those used in a turbine for another installation, which gave 775 HP. under a head of 30 ft., operating at a speed of 220 r. p. m., and which under these conditions gave an efficiency of 81%. He then makes his calculations to determine what power this turbine will give when operating under a head of 40 ft. Knowing that the output of a turbine varies as the three-halves power of the head, provided the speed is allowed to vary as the square root of the head, he obtains the following results:

$$\text{Output} = 775 \times \left(\frac{40}{30}\right)^{\frac{3}{2}} = 1{,}190 \text{ HP.}$$

$$\text{Speed} = 220 \times \sqrt{\frac{40}{30}} = 254 \text{ r. p. m.}$$

He knows also that if the turbine is operated under the head of 40 ft. and at the speed of 254 r. p. m., which is the normal speed for that head, it will have the same efficiency which it had when operating at the proper speed for the 30-ft. head, which on test was found to be 81%. For the new conditions, however, only 1,000 HP. is desired, or 84% of the normal power of the stock turbine for a head of 40 ft.; also, the speed required is 275 r. p. m., which is considerably above the normal speed of 254 r. p. m. The question then arises as to how much the efficiency of the turbine will fall below 81% when it is operating at 84% of its normal power and at a higher speed than normal. If the manufacturer figures that the efficiency will not fall below the required guarantee of 80%, he prepares his proposal on a basis of utilizing his stock apparatus. The normal capacity of the turbine is, therefore, rated at 1,000 HP. instead of 1,190 HP., and the manufacturer plans to block the wheel gates so that they will not open beyond the point required to give 1,000 HP.

The Fields of the Two Classes.

THE STOCK TURBINE.—The principal field of application for the stock turbine is for heads under 100 ft. and for capacities not exceeding 2,000 HP. Owing to the absence of development charges and the resulting low first-cost of this class of apparatus the stock turbine has a great advantage within this range, and the market for the made-to-order turbine, within these limits of head and power, is confined to cases where the question of efficiency is of prime importance, or where unusually high factors of safety are required in the construction, owing to peculiar local conditions.

THE SPECIAL TURBINE.—The made-to-order turbine finds its application to installations where one or more of the following requirements are of principal importance:

(1) High efficiency.

(2) Non-erosion of the runner vanes—a requirement which becomes more important the higher the head.

(3) High factors of safety in the construction of the apparatus.

(4) Low operating expense.

(5) Unusual design called for by peculiar local conditions.

(6) Capacity considerably above the range to which the stock turbine may be applied.

(7) Head much over 100 ft.

In all of these cases the question of first cost must necessarily be of secondary importance.

The Value of Extra Efficiency.

In installations where special turbines are required and where efficiency is the most important of all considerations, it has been customary in recent years for the purchaser to require the manufacturer to guarantee the efficiency of the apparatus on a bonus-and-penalty basis; the rate depending upon the value to the purchaser of that increase in the power output which is obtained by a gain of 1% in the efficiency. A common rate has been $1,000 for each per cent. per turbine.

For example, assume that the turbine manufacturer guarantees an efficiency of 80% on a 10,000-HP. turbine. If the turbine, on test, is found to have an efficiency of only 79%, the power output of the wheel when consuming a quantity of water corresponding to the guaranteed efficiency of 80% will be about $10{,}000 \times 79 \div 80 = 9{,}875$ HP. Thus the loss in power for the guaranteed consumption of water will be $10{,}000 - 9{,}875 = 125$ HP. Or, conversely, assume that the turbine on test is found to have an efficiency of 81%; the power output of the wheel when consuming a quantity of water corresponding to 10,000-HP. output at the guaranteed efficiency of 80% will be about $10{,}000 \times 81 \div 80 = 10{,}125$ HP., a gain of 125 HP.

The value of 125 HP. for a year may be figured in dollars and cents by the purchaser, and the rate of the bonus and penalty depends upon this value. If, for example, the purchaser is able to sell his output on a basis of $20 per horsepower per year, the value of 125 HP. in a year's time would be $2,500, and if by a special effort the contractor exceeds his guarantee by 1%, and receives a bonus of $1,000, the purchaser would be the gainer in the first year by $1,500; in the second year and each succeeding year, however, he would be the gainer by $2,500.

The Cost of Extra Efficiency.

If the contractor exceeds his guarantee by 1% it does not necessarily follow that he has made $1,000. Especially is this true when the value guaranteed is about the highest efficiency which would be expected for the conditions of power, head and speed, and the contractor, in an effort to exceed his guarantee, goes to considerable expense in the construction of experimental runners, which he tests at the Holyoke Testing Flume or some other convenient place.

If the preliminary tests are made, the experimental runner which gives the highest efficiency is the one selected to be the model for the large runner to be installed in the turbine. The large runner is accurately stepped up from the model runner, and when completed will have the same vane angles and the same relative sizes of entrance and discharge areas as the model. The model, when operating at its point of maximum efficiency in Holyoke and at a speed and power suited to the head at the Holyoke flume, will have the same characteristics as the large turbine when running at maximum efficiency and at the normal conditions of power, head and speed. The efficiency of the model runner is a very accurate forecast of the efficiency which may be expected in the final test of the large turbine in place; it being assumed, of course, that the wheel-casing and the draft-tube of the large turbine have been properly designed.

In addition to the cost of making the experimental runners and having them tested at Holyoke, the contractor will often go to the expense of constructing the turbine of more liberal proportions than he counted on when he signed the contract. The cross-sectional areas of the water passages of the turbines are increased, so as to reduce the frictional losses and increase the efficiency correspondingly. The extra expense is justified, provided the experiments and the enlargement of the turbine do not increase the cost by more than $1,000 for each 1% gained in the efficiency. If the manufacturer comes out even, he is still the gainer, owing to the fact that he has exceeded his guarantees, a condition which should bring him additional business in the future.

Erosion of Vanes.

In the past the stock turbines as a class have experienced much trouble from erosion of the wheel vanes. Especially has this been found the case when they have been applied to the higher heads.

Erosion depends primarily upon the design. To eliminate erosion, among other things, the hydraulic design must be very close to the correct, and the allowable variation from the correct is less the higher the head. As has already been pointed out, in a majority of the applications of the stock turbine the conditions of power, head and speed are somewhat different from those for which the wheel was originally intended; consequently the design cannot be said to be very near to the correct. The natural result, in a great number of cases, is the rapid erosion of the wheel vanes, a condition which not only reduces the efficiency of the turbines at an accelerated rate, but soon destroys the vanes to such an extent that the runner or runners must be replaced. Thus the maintenance of the turbine becomes an important item.

Pressure Variations Caused by Governor Action.

Turbines which are fed by long penstocks are more or less subject to fluctuations of the pressure in the wheel-casing. In such cases it is extremely important to have the turbines designed especially to withstand the resulting variation in the stresses in the wheel-casing and head plates.

The magnitude of a pressure change, among other things, depends upon the length of the penstock and upon the rate of the change of the velocity of the water in the penstock. The rate of change of velocity depends upon the velocity of the wheel gates as they are moved by the governor to suit the variations in the load.

When the gates of a turbine close to suit a drop in the load, the velocity of the column of water flowing in the penstock is decreased at a rate depending upon the velocity of the closing gates. As it requires a force to decrease the velocity of a moving body, the force is evidenced by a rise in the pressure in the wheel-casing. Conversely, when the gates of a turbine open to suit an increase in the load, the velocity of the column of water flowing in the penstock is increased at a rate depending upon the velocity of the opening gates. As it requires a force to increase the velocity of a moving body, the force is evidenced by a fall in the pressure in the wheel-casing.

The question of the pressure variations to which a turbine may be subjected deserves the most thorough study before the various parts are proportioned and the thickness of metal chosen. The reader will appreciate the importance of having the apparatus designed and constructed to meet safely the severe strains imposed by the variation of the pressure in the turbine casing.

The elementary action involved in these pressure fluctuations is not very complex. But in actual practice there are many influences which modify the phenomenon to a greater or less degree, and consequently it is practically impossible to derive a formula which would take into consideration all the phases of the subject. Approximate results, however, may be calculated which should be of value to the designer.

Among the modifying factors which influence the pressure fluctuations might be mentioned the following:

1. Friction loss in the penstock, which varies about as the square of the velocity.

2. The expansion or contraction of the walls of the penstock as the pressure rises or falls. This expansion or contraction is a maximum at the section nearest the turbine wheel, becomes less in magnitude as we go along the penstock, and is zero at the headgates, where the pressure fluctuation is zero.

3. During the movement of the turbine gates the discharge through the wheel is not proportional to the gate opening, as the simple theory assumes. A rise in pressure in the penstock may in fact momentarily increase the discharge as the gates close, and vice-versa.

4. The compressibility of the water, which reduces the impact of the water-column.

Assuming, however, that the penstock is frictionless and inelastic, and also that the discharge is proportional to the gate opening, and that we are dealing with an incompressible fluid, it is possible to derive a simple formula from which we may obtain results close enough for all practical purposes.

FORMULA FOR PRESSURE FLUCTUATION.—We know from analytic mechanics that force is equal to mass times the acceleration.

$$F = m\ a \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

also $m = \frac{W}{g}$, where W equals the weight of the body and g equals the acceleration due to gravity = 32.2 ft. per second per second.

Also, the acceleration is the rate of change of velocity

$$a = \frac{v_1 - v_2}{t}$$

where v_1 is the velocity of the body, in feet per second, before it is acted upon by the force F; v_2 is the velocity of the body after the force has ceased to act; and t is the time, in seconds, required to change the velocity of v_1 to v_2, or from v_2 to v_1.

Also, in the case of a mass of water flowing in a penstock, the force F is equal to the pressure change in pounds per square inch, p, times the cross-sectional area of the penstock, or

$$F = A \times 144 \times p,$$

where A is equal to the cross-sectional area in square feet.

Substituting the above values of m, a and F, in equation (1), we have

$$A \times 144 \times p = \frac{W}{g} \times \frac{v_1 - v_2}{t} \quad \ldots\ldots\ldots\ldots (2)$$

Since the weight of the column of water in the penstock, W, is equal to $L \times A \times 62.4$, where L is the length of the penstock in feet and 62.4 is the weight of a cubic foot of water, the above equation becomes

$$144\ A\ p = \frac{62.4}{g}\ A\ L\ \frac{v_1 - v_2}{t},$$

and solving for p we have

$$p = 0.0134\ L\ \frac{v_1 - v_2}{t} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

Consider, for example, a turbine operating under a normal head of 50 ft. and fed through a penstock 500 ft. long. Assume that the velocity of the water in the penstock, when the turbine is delivering full power, is 10 ft. per second. The normal pressure in the wheel-casing will then be that corresponding to 50 ft., less the draft head, which may be assumed to be 15 ft. Therefore, the normal pressure would be 15.2 lbs. per sq. in. Let us assume that, while the turbine is operating at full load, the load suddenly drops off to zero and the gates move at a uniform rate from the wide open to the closed position, and that the time of this movement is 2 seconds. Referring to formula (3), we may calculate the approximate value of the rise in pressure:

$$p = 0.0134 \times 500 \times \frac{10 - 0}{2} = 33.50 \text{ lbs. per sq. in.}$$

The rise in pressure over the normal is, therefore, found to be 220%.

It is seen that the rise or fall in the pressure is directly proportional to the length of the penstock, directly proportional to the difference in velocities corresponding to the two loads on the turbine, and inversely proportional to the time required to move the wheel gates. It is also seen that, for loads coming on the turbine, if the time for the movement of the gates is not adjusted to the inclinations of and the velocities through the various sections of the penstock, the fall in pressure may be such as to reduce the pressure in a section of the penstock below the atmospheric pressure and cause its collapse.

In actual practice the pressure fluctuations are considerably reduced by means of surge tanks, standpipes and relief valves. Still, in cases where very long penstocks are required and where rapid movements of the wheel gates are necessary to secure good regulation, the designers should appreciate the importance of going into this question thoroughly and of making liberal allowances in choosing the factors of safety in the construction of the turbine.

Owing to the rapid progress made in the design and construction of the made-to-order turbines, the hydraulic engineer has to contend with problems which were never solved before, and in each design encounters many features which were not fully appreciated or which were not anticipated at the time the contract was signed.

It has only been within the past few years that the literature on the subject of turbines has been sufficiently up-to-date to be of value to the designer as a guide in determining the proper constants for the hydraulic formulas and in working out the best mechanical detail. When a concern contracts to design and build a turbine whose successful construction and operation is likely to mark a distinct advance in the art, the designer of the wheel will invariably find himself confronted with problems to be solved without the aid of reliable data. In such cases, the question of the proper factors of safety to use in the design and construction is an extremely important one, as many things are at stake besides the reputation of the designer.

Experience is the greatest asset the designer has in enabling him to cope successfully with unusual situations. An experienced engineer is not only one who can turn out apparatus which is efficient hydraulically and mechanically, and free from erosion, but one who has a thorough knowledge of the best shop practice. The sizes of the various parts and the thickness of metal must be selected in accordance with the work each particular part has to do in the operation of the turbine, and we do not find in high-class machinery an abundance of metal in parts where it is not required, nor do we find a scarcity of metal in parts where liberal allowances should be made.

The engineer who designs a turbine for severe conditions realizes that he cannot afford to sacrifice metal or workmanship in an effort to reduce the cost to land a contract. Every concern engaged in the manufacture of hydraulic turbines knows from experience that there is no news that travels like bad news, and the free advertising which a manufacturer secures as a result of a failure is not of the sort to promote future business.

Some Notes on Sliding Sluice-Gates, Charles River Basin, Boston-Cambridge, Mass.

By WALTON H. SEARS.*

The Charles River Basin Commission has installed at various points on the work done under its direction a total of 36 cast-iron bronze-faced, sliding sluice-gates, varying in size from 20 × 30 ins. to 7½ × 10 ft. Of these gates, all but six are motor-operated. The following article records the Commission's experience to date with these gates and gives a brief account of a study made to determine the coefficient of sliding friction between gate and seat in sluice-gates of this type.

It is a well-recognized fact that a valve or sluice-gate with a rising stem is much to be preferred to one with a non-rising stem. Owing to local conditions of head room, however, the above gates are all, except five, of the latter type, enabling the faults of that type to be well observed. The great advantage of the rising stem is the accessibility of the screw for observation and lubrication. In many of the Commission's non-rising-stem gates the operating nut which is attached to the top of the gate is at about or just above the water level and not far below the operating floor, thus allowing the stem to be readily slushed with grease. In these cases, this type works quite satisfactorily except in so far as it entails having the operating stand supported overhead.

The 13 gates used for filling and emptying the lock in the Charles River Dam are of the non-rising-stem type and the operating nuts are about 20 ft. below the surface of the water. These gates are mounted on the lock-gates, six on the lower or down-stream gate, each 3 ft. 10 ins., by 4 ft., and seven on the upper gate, four of them 4 × 3½ ft., and three of them 3¼ × 3½ ft. The lock-gates are steel caissons (see Eng. News, July 9, 1908), which are exceedingly stiff as regards actual distortion but readily take up any vibration or jar. After the sluice-gates had been in operation but a short time it was evident that something was wrong, as the motors were overloaded and each operation was accompanied by much groaning and jarring which was magnified on account of the susceptibility of the lock-gates to vibration. The result was the speedy loosening of bolts attached to the lock-gate structure and also motor troubles. The contractor first attempted to rectify the troubles by substituting cut gears for cast gears where used in the operating stands. Some improvement resulted. The next step was to reduce the speed of operation by increasing the gear ratio. This gave further improvement as regarded the motors but it was evident that the seat of trouble had not been reached. It was then suggested that the lock be pumped out and the screws be examined and greased. This was done and it was found that they were wearing rapidly. After trying several greases, none of which would adhere to the wet shaft, a heavy cylinder oil was applied. On trying out the gates after the lock had been filled the change was marked, the gates running smoothly and satisfactorily with a considerable reduction in power. It was found, however, that owing to the lubricant gradually washing off the former undesirable conditions returned in a few weeks' time.

The problem was finally solved by the application of the compression grease cup shown in the accompanying illustration. This cup is arranged so that each time the gate is opened the rod A striking on a part of the lock-gate structure turns the ratchet B fastened to the square shaft C through an angle of 30 degrees, this advancing the plunger D a distance of 1/144-in. At the present rate of operation one filling of the cup should last from one to four months according to the number of lockages, which vary with the season of the year. If, however, those operating should neglect to fill it when necessary, no harm will be done as the plunger will simply run off the shaft and stops.

One of these cups, filled with a soft grade of Albany grease, was applied as an experiment and it was found to lubricate the stem well over the entire travel of the nut, and power observations show a saving of from 15 to 18% effected.

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It is intended that all the gates be operated at a speed of 2 ft. per min. The motors on the lock-filling gates are of 3-HP. rated capacity and gates of the following sizes are operated by 5 HP. motors. 7½ × 10 ft.; 8 × 8 ft.; 7¼ × 8½ ft., and 6⅛ × 6½ ft. All of these may be called upon to operate under any head up to 15 ft., and in many instances it has been found that at heads considerably less than 15 ft. the motors have been overloaded. For that reason when the Commission designed five gates, each 6 ft. 4 ins. by 7 ft. 8¼ ins., to be installed at the Fens Gate House* (the condition of head and operating speed the same) they were equipped with 7½-HP. motors and were designed with rising stems. Owing to the infrequency and short period of operation it is possible to use motors of the above power but wound in small motor frames, 1-HP. frames being used in the above case.

The controlling apparatus for all the motor-operated gates was furnished by the Cutler-Hammer Manufacturing Co., of Milwaukee, Wis. Each gate is provided with a limit switch which automatically stops the gate when in the fully closed or fully opened position. This device should be installed on all such gates. It has been found entirely reliable, but the best practice seems to be to set the limit to operate just before the gate is jammed into the wedges. The final seating can then be done by closing and releasing the circuit by hand. When finally home, the strain on the operating stand and supports is removed by reversing the motor for an instant, the back lash in the gearing allowing this without moving the gate. In addition, it is practically necessary to protect each motor by an automatic overload release which becomes operative in case the gate closes on a log or other obstruction.

*These gates were described in Engineering News, Feb. 25, 1909.

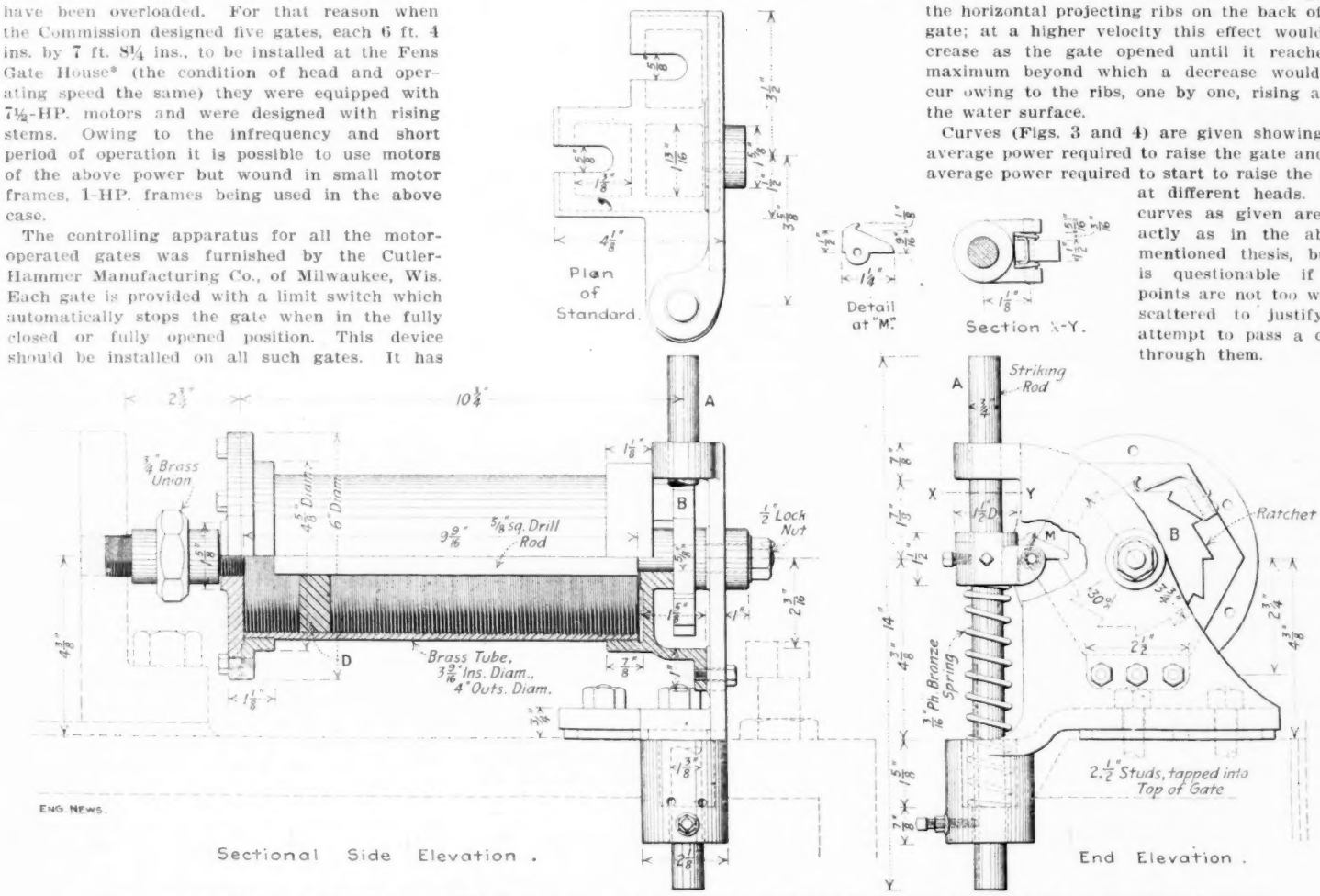

FIG. 1. AUTOMATIC COMPRESSION GREASE CUP OR VALVE STEM LUBRICATOR FOR CHARLES RIVER BASIN SLUICE-GATES.
(Built by Coffin Valve Co., Boston, Mass.)

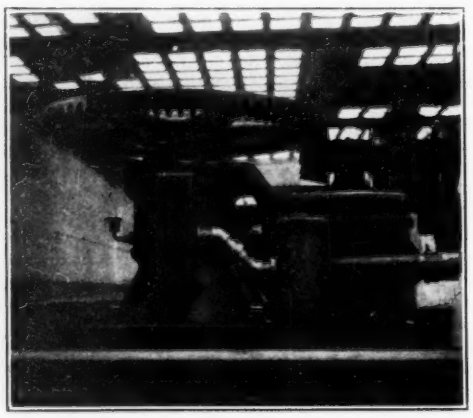

Fig. 2. Operating Stand of One of the Charles River Basin Sluice-Gates.

Tests to Determine Coefficient of Friction Between Sluice-Gates and Frame.

In the design of sluice-gates, one of the factors which it is desirable to know is the coefficient of friction between the seats of the gate and the frame. With a view to determine this, Messrs. C. W. Radford and W. C. York, graduates of the Massachusetts Institute of Technology in the class of 1909, made a series of experiments on one of the Commission's sluice-gates. The results of these experiments are so variable that the determination of the coefficient by the means used seems to be impracticable, but a description of the tests and some of the curves showing the results are of interest.

The gate on which the experiments were made is one of eight gates, having openings 7½ ft. wide and 10 ft. high, used to control the water level in the Charles River Basin. The gate is of cast-iron, with a bronze-bearing face sliding on a bronze facing or seat on a cast-iron frame set in the masonry. When in the fully-closed position, the gate is jammed against the seat by adjustable bronze wedges on its back. It has a non-rising, 6-in. diameter, bronze stem engaging a bronze nut on the top of the gate. The stem is operated by the large gear, which is keyed to it and which is shown in the accompanying illustration of the operating stand. The gate was raised and lowered precisely as in practice and observations were made of the water levels above and below the gate, of the ammeter, voltmeter and of the speed of operation. Tests were made under heads varying from 0 to 8.7 ft., this range being made possible by the rise and fall of the tide on the down-stream side of the gate. The power observations showed that up to a head of 7 ft. more power was required to start the gate than to keep it in motion, but that at heads over 7 ft. the power required increased for some time after starting and then decreased uniformly until the bottom of the gate was out of water. This peculiar result is explained as follows: The coefficient of friction of rest being greater than the coefficient of friction of motion and the gate at the start being jammed into the wedges, more power would naturally be expected to be necessary at the start, but at the higher heads this is supposed to be more than offset by the downward filaments of water striking against the horizontal projecting ribs on the back of the gate; at a higher velocity this effect would increase as the gate opened until it reached a maximum beyond which a decrease would occur owing to the ribs, one by one, rising above the water surface.

Curves (Figs. 3 and 4) are given showing the average power required to raise the gate and the average power required to start to raise the gate at different heads. The curves as given are exactly as in the above-mentioned thesis, but it is questionable if the points are not too widely scattered to justify an attempt to pass a curve through them.

In general the Commission has found gates of the sliding type quite satisfactory, the most serious difficulties encountered being the necessity of lubricating the lock-filling gates and the overloading of motors in many instances.

The Charles River Basin Commission consists of Hon. Henry D. Yerxa, Chairman, Hon. Joshua B. Holden and Gen. Edgar R. Champlin. Mr. William S. Youngman is Secretary and Mr. Hiram A. Miller, M. Am. Soc. C. E., is Chief Engineer.

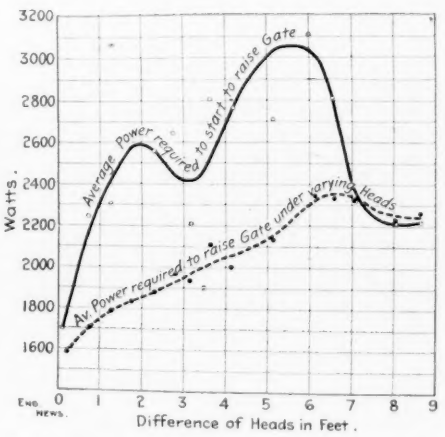
Watts.
Average Power required to start to raise Gate.
Av. Power required to raise Gate under varying Heads.
Difference of Heads in Feet.
ENG. NEWS.

Fig. 3. Power Required to Start and Average Power Required to Raise Sluice Gates Under Different Heads.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

220 BROADWAY, NEW YORK

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BOSTON: 43 Tremont Street
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Entered at the New York Post-Office as Second-Class Matter.

The unenviable position of this country as to the enormous aggregate of its annual fire loss and the lax enactment and enforcement of measures for fire prevention and protection against fire was stated very plainly and forcibly by Mr. C. M. Goddard in his annual address as President of the National Fire Protection Association at Chicago last week. An abstract of this address is given elsewhere. The enormous losses are due in part to the very extensive use of inflammable material in construction, but in large part also to defective features in construction. Two other contributory causes are: First, a lack of energy in the investigation of causes of fires, and the application of remedies, and also a general tendency to accept the conditions as unavoidable; and, second, a deplorable failure to enact (and more especially to enforce) measures for fire prevention and for protection against fire. These conditions in relation to the fire-loss situation in this country have been presented many times, but we call attention to them again in connection with the address noted above and in line with the suggestion that the public may be aroused eventually to the seriousness of the situation if the facts are put before it prominently and repeatedly.

The channel width or length of clear span to be adopted for drawbridges over the Chicago River is a question now being disputed somewhat actively, in connection with the construction and reconstruction of several bridges across the main channel. The Pennsylvania Lines commenced work a short time ago on the foundations for a vertical lift bridge of 140 ft. span, plans for which had been approved by the War Department. The city has sought to stop the work by injunction on the ground that a clear opening of 200 ft. should be provided to give sufficient facilities for navigation. The War Department on the other hand has ordered the removal of some of the existing bridges, on account of insufficient waterway in one case (with a single span) and insufficient waterway combined with center-pier obstructions in other cases. The question of the length of clear span to be adopted for new bridges is therefore one that calls for prompt decision.

The city's harbor commission has recommended a width of 200 ft. at bridge openings as well as in the open channel, but, as the city's funds available for bridge work are very limited, it has been suggested that an appreciable saving might be made by limiting the clear span to 140 ft. The question is being discussed from many points of view, including the obstruction to both street and river traffic, the use of the river as a harbor and its relation to the sewage disposal problem. The city authorities are divided in opinion, but must decide in a short time whether the 140-ft. or 200-ft. width at bridge openings should be recommended. The War Department has called upon the city for a definite opinion, and one meeting has been held by the U. S. Engineer Officer in charge of the district. An extension of 30 days was given to allow the authorities time to discuss the matter and make their decision. Meantime, various opinions are being presented on the part of the city, the Sanitary District, commercial organizations and other interests.

One of the main features of the controversy is that relating to the future use of the river and the problem of whether the city should have an inland harbor or a lake front harbor. On the one hand is the proposition that the river shall be Chicago's principal harbor and be lined with wharves and slips. If this is to be done it is claimed that openings of 200 ft. width are necessary. On the other hand is the proposition that the river shall be used simply as a canal by vessels destined to special points on or beyond the river (leaving the harbor proper to be established elsewhere), in which case (it is claimed) bridge openings of 140 ft. would be ample.

Some of the principal arguments in favor of the shorter span of 140 ft. may be summed up as follows: (1) the 140-ft. opening is ample for navigation; (2) the additional 60 ft. width would involve great additional expense for the bridges without adequate benefit in return; (3) vessels lying at wharves in the 200-ft. channel between the bridges reduce the width of the navigable channel to a greater extent than the projecting abutments of 140-ft. spans; (4) pushing back the inclined approaches 30 ft. on the street line would cause property damages by cutting off light and means of access to the lower floors; (5) the river is to be considered as a navigable channel, and not as a harbor; (6) the additional waterway capacity required for dilution of sewage can be provided by means of by-passes behind the abutments.

On the other hand the following claims are made for the 200-ft. span: (1) the additional cost of the superstructures would be comparatively small and the property damage negligible; (2) the cost would be warranted by the advantages of a wider opening and a uniform width of channel between and through the bridges; (3) with the wider opening ships could pass more rapidly and the time of obstruction to street traffic would thus be reduced; (4) the river should be regarded as the harbor of Chicago, for general use by shipping, and should be given the greatest possible facilities both as a harbor and a channel for navigation; (5) the by-pass system would be unsatisfactory, and (with the projecting abutments) would induce irregular currents, unfavorable for navigation.

Without attempting to pass an opinion in this complicated case, we venture to point out that even with 200-ft. width openings at every bridge over the Chicago River, its navigation by large lake vessels will be a matter involving difficulty and risk. We showed very recently (in our issue of May 5, p. 427) the great difficulty of navigating an ocean or lake vessel in a narrow channel, and a channel of 200-ft. width is narrow for a vessel with the length and beam of the big lake freighters. Further than this, the difficulty of steering a lake or ocean vessel in a narrow channel are increased many fold if there is even a slight current in the channel. Everyone who has ever tried to push a boat or canoe up a rapid river knows how the boat's head tends to swing around the instant it veers either way from the center line of the current. The same forces tend to swing a steamer's head against either bank when a narrow channel is traversed against an opposing current.

There are 5 bridges across the main stream of the Chicago River, 13 over the South Branch and 17 over the North Branch. Besides all these bridges, many of which still have comparatively narrow draw openings, there are sharp bends in the channel. During two hours in the morning and two hours in the afternoon when the travel across the bridges is heaviest, the draws are allowed to remain closed. Major Thos. H. Rees has recently urged that these closed hours be abolished. The recommendation was made with the idea that the use of the river for navigation might in this manner be restored. It would seem to us more probable that opening the bridges in the rush hours would make the long suffering public demand that the drawbridge nuisance be done away with altogether. By the location of the harbor on the lake front, it would not be necessary for large vessels to traverse the river at all. Barges and tugboats, built low enough to pass under fixed bridges, could bring freight through the river from shippers located at the rear of the city and deliver it to lake vessels in the harbor.

The ease and expedition with which heavy passenger traffic is now handled at the Brooklyn Bridge terminal is of interest in connection with the congestion prevailing in the stations of the New York subway during the rush period. The methods of train and passenger handling in use at the Manhattan end of the bridge in the elevated-railway terminal are outlined elsewhere in this issue.

The carrying capacity of the New York subway (Interborough Rapid Transit) is controlled at present by the rate at which trains can be put through the combined local and express stations at 14th St., 42d St. (Grand Central Depot) and 96th St. These stations are the points of highest resistance to the flow of traffic because of the concentrated discharge from locals to express trains of passengers picked up by the locals at the several intermediate stations.

Grand Central is most in evidence as a point of congestion in the subway system because it is so situated as to bear the brunt of the most concentrated flow during the evening rush period. Passengers collected by the locals from points all along in the great manufacturing, store and office district between 14th and 42d Sts. change for express trains at Grand Central. Below 14th St., in an even more crowded district, the evening rush traffic is in part directed toward Brooklyn, which relieves the northbound trains. At the same time, congestion of southbound trains by the Brooklyn traffic, at 14th St. and below, is prevented by the supplementary outlets over the Brooklyn and Williamsburg bridges.

At the 96th St. station, the trouble is largely one of inefficient track arrangement at the branching of the Broadway and Lenox Ave. lines, and cannot be entirely relieved without rearranging the cross-overs. The fact that trains do accumulate at all at 96th St. in the evening rush is evidence that there is somewhat greater constriction here than at Grand Central, since it proves that the train rate limit set by the 96th St. station is lower than that already established by the Grand Central station. It is worth remark, however, that platform interchange delays cut a large figure even at 96th St., chiefly because of heavy interchange between Broadway and Lenox Ave. trains. Therefore, if means were developed for facilitating or regulating the flow of passengers at stations, it is certain that the capacity of 96th St. station could be appreciably increased even without rearranging the tracks. At Grand Central, of course, the trouble is wholly a matter of passenger handling, that is, of time consumed in unloading and loading of trains.

While it is evident that there is room for considerable improvement in the subway in this matter of facilitating loading and unloading, the

common belief is that no great improvement is possible, on the ground that the bad conditions are inevitable with the extremely heavy traffic handled. But the fact is that much better conditions are maintained in the elevated terminal at the Manhattan end of the Brooklyn Bridge, where the traffic is even more positively concentrated than in the subway. The possibility of segregating the loading and unloading operations to separate platforms in the bridge terminal is of course an essential advantage, but it is not the only factor: Regulation of the crowding must be conceded to deserve a share of the credit. Were similar regulation secured on the station platforms of the subway, marked improvement would result.

It appears that the managers of the subway traffic could study the operation of the bridge terminal with profit. Even if the adaptation of the bridge methods to the subway should not produce much increase of traffic capacity, yet it would certainly reduce the excessive crowding on the station platforms. And this is more than a matter of comfort, merely, for on several occasions it has resulted in fatal injuries, when persons have been crowded off onto the tracks or have been caught and crushed between car and platform.

Although the Public Utility Commission established recently by the New Jersey legislature has but limited powers compared with those lodged in the New York and Wisconsin commissions yet the creation of the New Jersey Commission is at least a long step in the right direction. As may be seen from the note published elsewhere in this issue, such powers as the Commission has extend to every class of public-service corporation operating under state or municipal grants in New Jersey. The Commission is empowered to compel all public-service companies to observe various laws and proprieties. It may investigate accidents and it may also hear complaints concerning rates, but after doing this it can merely make "such recommendations as it may see fit concerning accidents and rates." It has power to compel the attendance of witnesses and swear them and to compel the production of papers and accounts, and it is authorized to require corporations performing a given class of service to keep uniform accounts. Some control over the issue of securities is vested in the Commission.

The act, as frequently happens in securing legislation of this class, is a compromise measure, secured after a hard fight and after complete defeat in the legislature of 1908. Nevertheless it makes it possible for the Commission to throw a veritable searchlight on many of the affairs and operations of the public-service corporations of the state. In view of the spirit of the present time the Commission has only to show a wise exercise of its powers, limited though they may be, to ensure periodic grants of additional power until in point of authority it stands on a par with any Commission in the country.

The Rapid Spread of the Commission Plan of City Government.

Seldom has an innovation in municipal administration gained so rapidly in popular favor as the so-called commission plan of city government. Adopted less than ten years ago as an emergency measure at Galveston, Tex., after the great flood of 1900, the plan worked so well there that it appealed to other cities and towns as a ready means of relief from misgovernment, by the substitution of business for political methods of city administration. To-day, many of our readers will be surprised to know, some 70 cities, in no less than 17 different states, are already working under or have recently voted to adopt the commission plan.

Originally the commission plan, in essence, was nothing more or less than the substitution of five men, including the mayor, for the old and often cumbrously large city council of one or perhaps two branches, and also for a considerable number of administrative boards or departments. There speedily became associated with the commission plan a number of features which experience and reason showed to be almost essential if the people were to be saved from danger of autocratic control by these small bodies of men with such broad powers. These features include the "recall" of elective officers, the initiative and the referendum, each and all of which are too well known to need explanation here.

It is not our purpose to discuss the merits or demerits of the commission plan at this time, but rather to present to our readers a list of the cities reported as having adopted the plan. For convenience, we also give the populations of these cities. Unfortunately it is impossible to give the populations of the present time, and as estimates are so unreliable, and as comparatively few states have a census of their own between the decennial censuses of the United States, we have thought it best to make our population figures those for the United States census of 1900. While in some cases these populations do not serve fairly for comparative purposes, yet on the whole they will give a good general idea of the relative sizes of the cities which have adopted the commission plan.

In many instances, however, it will be understood that the places of only a very few thousand population in 1900 have now doubtless several times that number of inhabitants. We mention this, lest any one should conclude that the commission plan is mostly confined to places of inconsequential size, comparable, in fact, to the rural townships of New England which have long been governed by a board of selectmen—in many respects the prototype of the commissions we are considering.*

As may be seen from the table, both Memphis, Tenn., and St. Joseph, Mo., had populations of slightly over 100,000 in 1900; while Des Moines, Ia., Kansas City, Kans., and San Antonio, Tex., had more than 50,000 inhabitants each, and a respectable number of other cities in the list had populations of from 25,000 to nearly 50,000 by the census of 1900. The size of many of the cities in the list shows that in the opinion of considerable numbers of city dwellers the commission plan of government is suited to places of fair size.

Several cities, at least, which have not been willing to "go the whole figure" of the commission plan, have adopted some of its most essential features, particularly the small city council and measures to eliminate partisan politics from elections. The most notable example of this sort is Boston, which within the past few months has changed from a bicameral city council of well toward a hundred members, to a single-chambered council of only nine members, all elected at large; while at the same time adopting nomination by petition as a means of eliminating party politics from municipal affairs. Early in March of the present year, Seattle adopted what might be described as a semi-commission plan, but what was really an amendment to the old charter providing for non-partisan primaries and ballot, and also for 9 councilmen-at-large in place of 18 ward councilmen and 4 councilmen-at-large.

An examination of the table which we print herewith will show that the Northwestern and the Southwestern groups of states have together some 50 out of the 70 cities which have adopted the commission plan. Texas—quite properly, since the plan originated there—has 17 of the cities in the list, while Kansas has 16. There is a marked drop from these high figures to Iowa, with its five commission-plan cities. It is perhaps somewhat remarkable that no more of the Iowa cities than five should have adopted the commission plan, since it has been largely due to the interest and enthusiasm created by the Des Moines modifications that the commission plan has gained such popular favor throughout the country in general. Indeed, this scheme of municipal government is now more commonly called the "Des Moines" than the "Galveston" plan.

Massachusetts alone, of all the New England and Middle Atlantic states, appears in our list of commission-plan cities. The North Central group has only one representative, the South Atlantic and South Central have seven.

While the North Central group of states is barely represented at all in the list, it should be noted that the state of Michigan has recently adopted constitutional amendments and passed legislative statutes almost revolutionary in the degree to which they confer municipal home rule upon the cities and towns of that state. A movement for similar sweeping changes in Wisconsin is now on foot.

We put forward this list largely for the convenience of those who are attempting to follow the commission-plan movement. We have not seen anything like so complete a list published elsewhere. We should appreciate having corrections suggested and additions made to the list.

TENTATIVE LIST OF CITIES OF THE UNITED STATES REPORTED AS HAVING ADOPTED THE COMMISSION PLAN OF GOVERNMENT UP TO ABOUT MARCH 15, 1910.

(The populations given are those of the U. S. Census of 1900, unless otherwise stated.)

	No. of cities.	Population.
Total United States	68	1,202,836
New England States	3	97,368
Massachusetts	3	97,368
Chelsea		34,072
Gloucester		26,121
Haverhill		37,175
South Atlantic States	3	34,658
West Virginia	2	16,567
Bluefield		4,644
Huntington		11,923
North Carolina	1	18,091
Charlotte		18,091
South Central States	4	117,022*
Tennessee	4	117,022*
Bristol		5,271
Clarksville		9,431
Memphis		102,320
Richard City		(?)*
North Central States	1	17,517
Wisconsin	1	17,517
Eau Claire		17,517
Northwestern States	27	377,215
Iowa	5	158,748
Burlington		23,201
Cedar Rapids		25,656
Des Moines		62,139
Keokuk		14,641
Sioux City		33,111
Kansas	16	198,386
Abilene		3,507
Anthony		1,179
Coffeyville		4,953
Emporia		8,223
Hutchinson		9,379
Independence		4,851
Iola		5,791
Kansas City		51,418
Leavenworth		20,735
Marion		1,824
Newton		6,208
Parsons		7,682
Pittsburg		10,112
Topeka		33,608
Wellington		4,245
Wichita		24,671
South Dakota	3	13,827
Dell Rapids		1,255
Pierre		2,306
Sioux Falls		10,266
North Dakota	3	6,254
Bismarck		3,319
Mandan		1,658
Minot		1,277
Southwestern States	24	474,075
Missouri	1	102,979
St. Joseph		102,979

*Population of Richard City unknown.

*For several decades the local affairs of the District of Columbia have been administered by a commission of three members, appointed by the President and confirmed by the Senate of the United States; one of the members must be an engineer-officer of the Army. This district commission has been considered by some as the model on which the commission plan was based, but the similarity does not go far beyond the small size and broad administrative powers of the district commission and the various city commissions elsewhere. The latter exercise full legislative as well as executive functions, and are directly responsible to the people. Other communities of large size have also been governed by very small bodies in the past, New Orleans, if we remember rightly, affording the most notable example.

	No. of cities.	Population.
Texas	17	327,746
Austin		22,258
Beaumont		9,427
Corpus Christi		4,703
Dallas		42,638
Denison		11,807
El Paso		15,906
Fort Worth		26,688
Galveston		37,789
Greenville		6,860
Houston		44,633
Kenedy		800†
Marshall		7,855
Orange		3,835
Palestine		8,297
San Antonio		53,321
Sherman		10,243
Waco		20,686
Oklahoma	3	16,713
Ardmore		5,681
Enid		3,444
Tulsa		7,588‡
Colorado	2	24,588
Colorado Springs		21,085
Grand Junction		3,503
New Mexico	1	2,049
Roswell		2,049
Pacific States	6	84,983
Washington	1	37,714
Tacoma		37,714
California	3	38,887
Berkeley		13,214
Riverside		7,973
San Diego		17,700
Idaho	2	8,382
Boise		5,957
Lewiston		2,425

†Estimated.
‡State Census of 1907.

LETTERS TO THE EDITOR.

The Physiological Effects of an Alternating Magnetic Field.

Sir: Referring to your note on Prof. Thomson's studies into the physiological effects of alternating magnetic fields, page 560, current volume of Engineering News, permit me to say that our English cousins are perhaps some 17 years behind the procession, for d'Arsonval published some results of the use of the oscillating magnetic field in 1893. See "Comptes Rendus," tome 117, p. 34, where you will find two illustrations showing, one a man's body within the solenoid, and the other a rabbit within the solenoid. D'Arsonval said then that the field had a powerful therapeutic effect on the body, particularly upon the lower organs, "as was shown by an analysis of the products of respiration." It is well to note, however, that D'Arsonval states that the patient was not conscious of any effects. It has been reported, though not on the best of authority so far as I have found out, that D'Arsonval continued his investigations of the effect of this field, and devised a coil which used with a certain frequency of oscillation cured arteric sclerosis in ten days or so, with about ten minutes of treatment each day.

Such reports credit D'Arsonval with using frequencies of 300 to 500,000 per second in 1903, and up to the astonishing figure of 1,000,000,000 per second for the treatment of arterial sclerosis. It is difficult to believe, however, that enough current could be forced through his coils, at such a frequency, to produce an effective magnetic field in which a patient could be treated.

It is interesting to note, in this connection, the use of a solenoid for therapeutic purposes by the late John Burry. His apparatus was patented July 8, 1902 (No. 703989). This was to be used on the ordinary 110-volt, 60-cycle, circuits and many remarkable benefits are well authenticated. I personally used it in 1900 in curing an obstinate case of bronchitis of ten weeks' standing, and I did it in less than an hour. It has given me complete relief from certain rheumatic affections. Mr. Burry used to say that he had cured pneumonia and inflammatory (but not muscular) rheumatism. He also had a letter from a Syracuse physician saying that he had cured locomotor ataxia by the use of the solenoid on a 110-volt, 60-cycle circuit. I know of a few physicians who are using this apparatus to-day. There is a full account of Mr. Burry's experiments and results in a book on therapeutics, but I do not remember the title, nor the publisher's name.

Very truly yours,

R. W. Barkley.

220 Broadway, New York City.

A Reinforced-Concrete Oven.

Sir: In answer to the inquiry of Mr. J. S. Calhoun, Jr., on a baker's oven of reinforced concrete in Engineering News, May 19, 1910, p. 598, the writer would advise fire brick linings in the furnace with a 2-in. space between the lining and the outside shell.

The lining should be anchored at intervals of 18 ins. each way on the sides, and the arches can be built in the usual manner. The steel reinforcement should not come within 3 ins. of the inside of the furnace part of the ovens and the walls should be not less than 12 ins. thick.

Before the linings are put in place, steam should be admitted to interior of the furnace for about 7 days, at the end of which time the forms should be removed and the air allowed to circulate freely over the concrete surface. At the end of 14 days, the linings may be placed and allowed to season for at least 10 days in moderately dry weather.

In starting the fires it would be well to refrain from creating too high a heat in a period of less than 48 hours.

By observing these precautions a very efficient furnace can be constructed that will not show excessive cracking when fired, assuming that the general design is correct in other respects.

Yours very truly,

Benjamin L. Williams.

West Orange, N. J., May 20, 1910.

Owned vs. Rented Concrete Construction Plants.

Sir: The accompanying table gives some very interesting figures compiled from ledger records kept on four Smith concrete mixers by the Aberthaw Construction Co., of Boston, Mass., during the past seven years. The yardage given is as close an approximation as it was possible to obtain.

This company runs a ledger account for each machine charging the original cost, repairs, etc., against it, and crediting a rental of so much per day for the elapsed time while the machine is on a job. This rental is fixed as near as possible at what the rate would be if the machine were leased temporarily from the manufacturer.

An analysis of the table shows a saving 11 cts. less 8.94 cts., or 2.06 cts., per cu. yd. on plant cost for a plant bought outright over a rented outfit, it being assumed that the cost to the Aberthaw Construction Co. of renting would be practically the same as their charge to clients as shown in Table II. This saving was effected when the mechanics were on jobs 45.4% of the time owned. It will be noted on referring to Mixer No. 4 that the saving is 7.84 cts. per cu. yd. when rented 62.7% of the time owned, while on Mixer No. 2 there is actually a loss of 0.55% per cu. yd. when rented 28.1% of the time owned.

Another variable entering into the question is the time owned. It seems that Mixer No. 4, owned 1,302 days shows the maximum economy for the owner, although No. 6, a newer machine on larger yardage showing considerably less plant cost per yd., is not as economical for the owner as No. 4.

There are so many conclusions which might be drawn from a careful analysis of these figures that it is left to the reader to draw his own. However, in closing, attention is called to the fact that it appears to the contractor's advantage to buy his plant outright when he expects to work on moderate yardage over a considerable length of time. On large yardage quickly placed, there is not much difference between renting and buying.

Furthermore he should have his plant on jobs at least 50% of the time and the life of a machine for maximum efficiency is apparently in the neighborhood of 1,300 to 1,500 days, say 4 to 5 years. After that, interest, repairs and depreciation soon throw the balance in favor of rented plants. It is also evident that the entire cost of the original machine should be charged off to depreciation account in about 6 to 7 years. This charge to be over and above all repair costs.

Very truly yours,

Walter B. Snow.

170 Summer St., Boston, Mass., May 14, 1910.

TABLES SHOWING COST PER CU. YD. OF MIXING CONCRETE IN AN OWNED AND IN A RENTED PLANT.

TABLE I.—STATISTICS OF OWNED PLANT.

	Mixer number— 2	3	4	6	Totals & average.
Date of purchase	8-18-03	6-10-04	6-7-06	6-5-07	
Original cost	$625.00	$975.00	$975.00	$935.00	$3,510.00
Interest at 6% to Jan. 1, 1910	281.51	368.90	220.57	153.37	1,024.35
Repairs to Jan. 1, 1910	941.87	350.29	216.43	437.01	1,945.60
Total cost to Jan. 1, 1910	$1,848.38	$1,694.19	$1,412.00	$1,525.38	$6,479.95
Inventory value to Jan. 1, 1910	$125.00	$325.00	$400.00	$500.00	$1,350.00
Net cost to Jan. 1, 1910	$1,723.38	$1,369.19	$1,012.00	$1,025.38	$5,129.95
Total yards mixed	12,350	15,500	10,500	19,000	57,350
Plant cost per yard	$0.1395	$0.0883	$0.0964	$0.0540	$0.0894

TABLE II.—STATISTICS OF RENTED PLANT.

	Mixer number— 2	3	4	6	Totals & average.
Days owned to Jan. 1, 1910	2,325	2,029	1,302	939	6,595
Days rented to Jan. 1, 1910	827	7.8	816	536	2,997
Per cent. of days rented	28.1%	28.3%	62.7%	57.0%	45.4%
Rental rate per day	$2.00	$2.25	$2.25	$2.25	.....
Total rental to Jan. 1	$1,655.00	$1,616.25	$1,835.25	$1,204.50	$6,311.00
Total cu. yds. mixed	12,350	15,500	10,500	19,000	57,350
Plant cost per cu. yd.	$0.1340	$0.1042	$0.1748	$0.0634	$0.1100

TABLE III.—COMPARISON OF OWNED AND RENTED PLANTS.

	Mixer number— 2	3	4	6	Totals & average.
Plant cost per yard A	$0.1395	$0.0883	$0.0964	$0.0540	$0.0894
Plant cost per yard B	$0.1340	$0.1042	$0.1748	$0.0634	$0.1100
Per cent. saving by owning plant (based on rental cost)	*—4.1%	+15.25%	+44.8%	+14.7%	+18.72%

*This mixer showed a loss instead of a saving.

The Need of Topographical Maps in Planning Undeveloped City Areas.

Sir: The paper of Nelson P. Lewis, M. Am. Soc. C. E., on "The Planning of Undeveloped City Areas," is a very competent presentation of a timely subject. The writer feels, however, that Mr. Lewis has made one statement which in his own experience is not entirely correct:

> Do we first need an actual topographical map of the entire area? This involves a large expenditure of time and money, which, in the judgment of the writer, could be spent to better advantage.

Does not the truth of this statement depend upon the nature of the area involved? In an experience of nearly twenty years in the hill district of Philadelphia and the more rugged country of Pittsburg and Western Pennsylvania, an accurate topography of the entire area involved has almost invariably proved to be necessary for the intelligent consideration of city and street projection. In the Western Pennsylvania district especially, where slopes of 25% are common even in good residence districts, there can be no intelligent consideration of a building area that is not based upon the topography. Indeed, very frequently, a strict adherence to topography is necessary even to the exclusion of other important and desirable features.

Coming from such an eminent authority as Mr. Lewis, the statement may have a very unfortunate influence. Many of the poor town projections of Western Pennsylvania are the direct results of the lack of consideration of the topographical features of the country, due to the absence of a proper topographical plan. The writer cannot believe that Mr. Lewis would indorse such careless and unintelligent procedure, still too common even at this time. Indeed, one of the greatest difficulties that Pittsburg engineers encounter is to persuade clients that topographical surveys of the entire property is not a waste of money, but an absolute necessity in order to secure the best results. In every case, however, in which the writer has been concerned, the results obtained from such a survey have undoubtedly justified such expenditure.

In conclusion, the writer would express the opinion that there can be no set rule laid down. A careful preliminary investigation of the area involved and a consideration of the results to be obtained must decide in each particular case what features will govern the proposed projection; and if topography is the ruling feature, its expense will be amply justified by the results obtained.

Yours very truly,

Louis P. Blum.

Westinghouse Building, Pittsburg, Pa., May 16, 1910.

[At the conference at which the paper in question was originally presented there was some criticism of Mr. Lewis's statements regarding the need of topographical surveys *in advance* of extending the general plan of the city into undeveloped areas. In reply, Mr. Lewis made some remarks which showed that his meaning had been misunderstood. As we have no record of his exact language in response to those criticisms we have asked Mr. Lewis to reply to the communication from Mr. Blum. This he has kindly done, as appears in what follows.—Ed.]

Sir: I thank you for the opportunity to reply to the letter of Mr. Louis P. Blum, which refers to a statement contained in the paper on the "Planning of Undeveloped City Areas," which I presented at the recent Conference on City Planning at Rochester, N. Y.

As you say in your note following Mr. Blum's letter, the statement to which he refers was the subject of some discussion at the Conference, and I regret that I did not make my meaning clearer by the insertion of the words "at this time," so that it would have read "Do we first need an accurate (not actual) topographical map of the entire area? This involves a large expenditure of time and money which, in the judgment of the writer, could at this time be spent to better advantage." As will appear from what followed the quotation from my paper, special emphasis was laid upon the necessity of a careful study of the existing thoroughfares, which, with such additions or cross connections as might be necessary, would form the skeleton of the city plan, and so important did I consider this work that I put it first in order of procedure, so that the lines of these old roads as widened might be definitely fixed before improvements should be made which would render their acquisition and improvement on the new lines unnecessarily expensive. As I stated in the discussion which followed the reading of my paper, the need for a topographical survey and map before street lines and grades can be fixed for the subdivisions between the main thoroughfares is so apparent that it is scarcely worthy of emphasis.

I regret that the statement quoted by Mr. Blum should have been construed as showing a lack of appreciation of the importance of topographical work, although I believe that in some cases this work is done with a minuteness which is unnecessary.

Yours very truly,

Nelson P. Lewis.

New York City, May 21, 1910.

The Height of Bridges Over Navigable Streams.

Sir: Your leading editorial in the issue of April 14, 1910, on "Bridges over Navigable Streams—The Interference of Water Traffic with Land Traffic" contains some timely reflections on an important subject and also some statements in illustration thereof that would be interesting and pertinent, if true. It very properly invites attention to the possibility of bridge requirements imposed in the interests of navigation resulting in greater burdens than benefits for the general public.

The editor was unfortunate, however, in the source of his information about the situation with reference to the low bridges over the Allegheny River in Pittsburg Harbor, and he has been led to make a number of assertions that are of doubtful validity. The matter is of such importance as to make it seem worth while to give a brief account of the real conditions for the benefit of your readers.

There are eleven bridges over the Allegheny River at Pittsburg and three more above Pittsburg within the limits of slackwater, which extends about 24 miles upstream from the mouth. There are ten bridges crossing the Monongahela River at Pittsburg and nineteen above Pittsburg within the limits of the slackwater, which in this case extends upstream about 128 miles. In other words throughout a continuous stretch of about 142 miles of slackwater provided at a considerable expenditure of public funds, there are 43 bridges.

All the bridges over the Monongahela except two (at which plans for raising the height have already been made) have a headroom beneath them of not less than about 50 to 52 ft., which is the standard adopted by the War Department for these waters. This headroom exists also under all the bridges except the first eight on the Allegheny, all of which cross the river within 3.5 miles of its mouth. These eight include six highway and two railroad bridges. Their height above normal pool level varies from 27.7 ft. to 36 ft. Your statement that "until about ten years ago there was never any complaint from the river navigation interests as to the height of these bridges" looks odd alongside the following statement made by Major Merrill in annual report of 1879:

> Steamboat commerce on the Allegheny has almost been extinguished by railroad competition, by natural obstructions in the river, and by obstructions that man has put there in the shape of low bridges, with narrow spans badly located. There is hardly any river that shows more clearly the utter inadequacy of state laws to protect river commerce from wanton injury. The laws of Pennsylvania on the subject of bridges may be models of legal wisdom, but their results, as seen in the structures built under their authorization, are disastrous. The United States has not interfered, and the Allegheny is merely one of a number of rivers on which cheap transportation has been injured or destroyed by sheer negligence.

With reference to the commerce on the Allegheny affected by the bridges in question, the best information available indicates that it is greater than it was 20 or 30 years ago instead of only a small fraction thereof as you state. Your further statement that the question of raising these bridges has been twice passed upon and that both Secretary Root and Secretary Taft decided that no necessity existed for raising the bridges, is also open to question. Secretary Taft's decision was not against raising the bridges, but simply against granting a rehearing of the question based on the same evidence that was submitted to his predecessor. In fact his opinion that the bridges should be raised is clearly indicated in the following quotation from his decision:

> I have looked into the question with very considerable care in respect to the attitude of one Secretary of War toward the decision of another, or of the same Secretary of War with respect to his own decision, in a matter involving property investments like this, and I have given careful attention to the evidence upon which Mr. Root acted. I am inclined to think from the evidence that it would be very much better for the City of Pittsburg, for the City of Allegheny, and for the people living along that river to have those bridges put up now, and that it would be a better thing for them to have a decree made clearing the situation, as it must ultimately be cleared in view of the improvements that are likely to come, but Mr. Root took all this evidence fully into consideration and reached the conclusion that the time had not arrived in which he could say that the pressure for improvement in river navigation was such that these bridges had become unreasonable obstructions. That was the action of the Secretary of War under a statute delegating to him the decision as to whether these bridges were unreasonable obstructions or not for the purpose of issuing a decree requiring their elevation. It is upon exactly the same evidence and upon exactly the same state of law as I understand it, because he could not have issued his decree in the Union Bridge case without following that principle of law which was subsequently laid down in the decision of the Supreme Court of the United States.
>
> Now for that reason I am going to dismiss the petition for a re-hearing, but I am going to accompany it with this statement that when this decision comes before me, if any such decision shall come before me, for the construction of any bridge I am going to require it to be put at 47 ft., because I have been much impressed with the argument of one of the counsel that this mass of bridges has been used to prevent the improvement of any of them. * * * *

You also make the surprising statements "that at low water the present bridges are no obstruction to traffic in any ordinary-size steamboats," "that barges and not steamboats are the most economical method of transport on inland waterways," and that "of 13 towboats now operated in the Pittsburg pool, only one has a height of 24 ft. above the water."

Now as a matter of fact not one of the freight or packet boats entering Pittsburg Harbor can pass under the lowest of these bridges at low water (normal pool stage). In a list of 75 towboats operating in Pittsburg Harbor there are only eight that are less than 24 ft. above the water. Moreover, these are all comparatively light-powered boats, not suitable for general service on the rivers in this district. Of course, it is well known that while our commerce is mainly carried in barges, these are handled by steamboats, so that the latter must be taken into consideration in determining the height of a bridge. It has not been proposed to raise these bridges sufficiently to accommodate the larger Ohio River steamboats. That requirement (70 ft. above pool) was imposed only on the bridge at the mouth, which is now about to be rebuilt by the city. The ruling consideration in the changes proposed has been to provide passage on this river during all stages below that at which the locks of the fixed dams are submerged, for the standard boats navigating the Monongahela River. These ordinary pool towboats range from 26 to 28 ft. in height of fixed parts, while the standard packet boat is about 32.5 ft. high.

To one more or less familiar with these bridge questions your characterization of the river interests as the vested interests and the bridge interests as the public interests, is novel to say the least. Not one of these eight bridges belongs to the public. They are all the property of bridge companies or corporations. One belongs to the Pennsylvania Railroad System, which also owns the railroad lines that parallel the river and afford the only competition with it for transportation along the Allegheny Valley. In contrast with these privately-owned bridges, there is the navigable waterway belonging to the public.

With reference to the question of roadway grades, it may be pertinent to remark that the grades suggested for these bridges do not exceed the grades of approach already existing at one or more of them, and of course it is obvious that these grades can be reduced by raising the approaches any amount that may be considered advisable for this purpose. Notwithstanding the editorial approval given, doubtless in an absent-minded moment, to Mr. Morse's account of grade difficulties in a snowstorm on the Smithfield St. bridge, it seems unnecessary to remind your readers that the troubles he saw were hardly chargeable to a 2% grade. We have all seen horses practically helpless on smooth level pavements under such conditions of snowfall.

A further word about Mr. Morse's letter may not be amiss. Mr. Morse is, of course, well known to your readers as a bridge engineer. It is only fair to bear in mind when reading his views, that his sympathies are naturally and properly with the class of his employers, the bridge owners. He often has to represent them in disputes with navigation interests about alleged obstructive features of bridges.

In reading his remarks about the changing demands of river interests in connection with the new Point Bridge one is impressed by some of the things he leaves unsaid. The old Union Bridge at the Point was the property of private parties. It was so low as to completely bar all Ohio River steamboats from that portion of Pittsburg Harbor in the Allegheny River, while the were able to go up the Monongahela to the Smithfield St. Bridge (0.8 mile). It was considered necessary to open the Allegheny River for them also, as far as the Sixth St. Bridge (0.6 mile). Accordingly steps were taken to compel certain changes in the bridge, and this was done at a time when many had grave doubts whether the Government could require changes in existing bridges without compensating the bridge owners. As a result of the action taken the old bridge was wholly removed and the City of Pittsburg submitted plans for a public bridge to take its place. Now is it really very surprising that in the first instance when contesting the matter with hostile parties on doubtful ground the river interests should have tended to limit their demands to the minimum consistent with any reasonable regard for navigation, while in the second instance they should expect and secure from friendly public officials somewhat greater concessions? The principal change was to substitute a two-span for a three-span bridge, with an increase of only about one-half of 1% in the grade of approach.

Of course, it is not my purpose here to argue that these bridges should be raised. That question is at present before a Board of Officers of the Corps of Engineers, and the final decision rests with the Secretary of War. I am only calling attention to certain facts that should be taken into consideration in dealing with the matter and that are needed to correct some erroneous impressions that your editorial doubtless gave many of your readers.

Very respectfully,

H. C. Newcomer,
Lt. Col., Corps of Engineers.

United States Engineer Office, 2111 Farmers Bank Bldg., Pittsburg, Pa., April 27, 1910.

[We give space with pleasure to Col. Newcomer's letter. The statements in our editorial as to traffic on the Allegheny River were based on information furnished us by a Pittsburg engineer of high standing. The same engineer furnished us at the same time a table which we reprint herewith showing the comparative traffic over and under five highway bridges over the Allegheny at Pittsburg.

As we understand it, the raising of these Allegheny River bridges is not urged on the ground of benefit to the open-river navigation on the Allegheny above Pittsburg. The total traffic on the upper Allegheny, according to Col. Newcomer's last official report, was only about 200,000 tons and this is mostly the floating downstream of timber and lumber rafts, railway ties, etc., and the tonnage of gravel, sand, stone, etc. The argument for raising the Allegheny bridges is that the coal boats from the Monongahela may come around into the Allegheny and ascend as far as the slackwater navigation extends, about 25 miles, delivering coal to manufacturing plants along the waterfront. Quoting further from Col. Newcomer's report:

> For the calendar year 1908 the commerce reported on that part of the river under the improvement for slackwater navigation was 536,129 tons of freight and 9,636 passengers. . . . The operation of the locks and dams on the Allegheny River, providing a system of slackwater navigation in connection with Pittsburg Harbor, will tend to give manufacturing plants in this section the benefit of the cheap river rates on coal and other supplies. This benefit, however, cannot be realized to any considerable extent until the low bridges on the lower Allegheny River are raised sufficiently to remove the very serious obstruction to navigation that they now present.

The clearance under the present Allegheny River bridges with the river at normal pool level, according to Col. Newcomer's statement in the above letter, varies from 27.7 ft. to 36 ft. The height of the Monongahela River towboats, he states, varies from 26 to 28 ft. while the packet boats have a height of 32.5 ft.

The question we would raise, then is why these boats should not be built with a somewhat smaller total height, so that they could pass under the present bridges? Surely there is nothing inherently impossible in this proposition; nor is it evident why the restriction in height should constitute any very serious hindrance to efficient and economical construction and operation. The only part of the boat's structure for which considerable height is absolutely necessary is the longitudinal trusses and it means only a little more weight to reduce the height of these by three or four feet.

In studying the accompanying table, then, it should be understood that the real comparison to be made is between, on one hand, the vast

traffic passing over these bridges, all of which will be burdened by each additional foot of height they are raised and on the other hand the restriction that boats to operate on the Allegheny River pool should be built with a clear height of about 25 ft. or less.

We fail to see where such a limitation in height could cause any real handicap to the operation of coal boats sufficient to be measured in increased freight rates.

We doubt very much, however, whether the river interests will take kindly to the suggestion that they build their boats to suit the present bridges. They claim the right of way and are willing to make someone else spend a thousand dollars rather than spend one themselves.

This is a good place to put on record a very recent occurrence at New York City, as reported in the "Times" of May 5:

The "Mary Ann," a two-masted schooner, loaded to the water's edge with brick, got stuck in the mud while attempting to pass through the Erie Railroad's drawbridge over the Hackensack River at the time New Jersey commuters were coming to work in the city yesterday morning. As a result 7,000 people were held up for two hours.

A trainload of commuters had just reached the river when the bridge swung open to allow the "Mary Ann" to pass through. The "Mary Ann's" skipper made frantic efforts to keep the boat in the channel, but the steering gear was broken.

Every 10 minutes trains loaded with commuters arrived until the stalled cars stretched back a full mile. The Erie's traffic department sent a large freight engine to the draw, but in order to get within working distance the passenger trains had to be switched on to sidings. A cable was stretched from the engine to the brick boat, and inch by inch the engine dragged the old hooker out of the mud.

We submitted a proof of the above letter to the Pittsburg engineer referred to above whose data we quoted in the original editorial. We print his reply below.—Ed.]

Sir: Being the Pittsburg engineer who furnished you the data on which you based your editorial of April 14, on "Bridges Over Navigable Streams—The Interference of Water Traffic with Land Traffic," and which Col. Newcomer, U. S. Engineer Corps, criticises in his letter of April 27, the writer would ask the use of your columns to reply to some of the Colonel's criticisms.

The Colonel makes the general assertion that "The Editor is unfortunate in the source of his information, etc." In reply to this assertion, the writer would say that the facts furnished you were all of them taken from sworn affidavits presented at the hearings before the Board of Engineers appointed by the Secretary of War to take testimony in the bridge raising cases.

He lays great stress on the fact that there are eleven bridges over the Allegheny River in the limits of the city, instead of five, as stated in your editorial. The writer is probably to blame for this as while he gave you the data regarding traffic over and under five bridges, he did not inform you that there were six more bridges, two of which are railroad bridges. The number of bridges over the Monongahela River, which the Colonel calls your attention to, has no bearing whatever on the Allegheny River bridges, as the question whether these bridges should be raised, the writer believes, depends entirely upon the traffic on the Allegheny River under the bridges, and the traffic on the bridges which span that river.

Colonel Newcomer takes exception to the statement that "Until about ten years ago there never was any complaint from the river navigation interests as to the height of these bridges," and proceeds to quote from Major Merrill's report of 1879. A careful reading of the extract which he gives from the report will show that Major Merrill simply gives his personal opinion on the subject and does not say that he had received any complaint from any of the boat owners. If Colonel Newcomer knows of any complaint laid before the War Department by any of the navigation interests previous to 1900, the writer would like to see a copy of it.

With reference to commerce on the Allegheny River, the Colonel makes the statement that "The best information obtainable indicates that it is greater than it was twenty or thirty years ago instead of only a small fraction thereof."

The writer has at hand no data as to *thirty* years ago, but he has data as to the last ten years. The figures *presented by the river interests themselves* at the hearing show that the traffic on the Allegheny River is decreasing. These figures show that the tonnage on the river for 1907 was just about one-half that for 1899, and the Government's own reports show the tonnage passing through the lock at Herr's Island Dam was in 1909 less than one-half what it was in 1904.

Exception is also taken to the statement that both Secretary Root and Secretary Taft decided that there was no necessity of raising the bridges.

Colonel Newcomer does not deny that Secretary Root so decided, but does not admit that Secretary Taft decided in the same manner. Technically, the Colonel is correct. Secretary Taft did not in so many words decide the bridges must not be raised, but in refusing to reopen the case, he practically in effect decided that the bridges need not be raised.

While on the question of Secretary Taft's decision, allow me to call your attention to the omission of a word in the quotation given from it by Colonel Newcomer. I would not for a moment charge the Colonel with intentionally misquoting the decision, but simply state the fact that the quotation as printed, has one very important word omitted. The quotation as printed says: "If any such decision should come before me for the construction of any bridge, I am going to put it at 47 ft." The correct quotation should be not "any bridge" but "any new bridge."

The statement in your editorial that "of 13 tow boats now operated in the Pittsburg Pool, only one has a height of 24 ft. above water," is taken from one of the sworn affidavits above referred to, which gives the actual height of each of these boats. Colonel Newcomer says, "While the standard packet boat is about 32.5 ft. high," and that ordinary pool tow boats range from 26 to 28 ft. Thus there is a difference, according to his figures, of from 4.5 to 6.5 ft. between the height of the two types of boats. As there is only one line of packet boats plying on the Monongahela River, a stream which has been slackwatered for years, is it probable that there would be any more or even any on the Allegheny River, which has a railroad on both banks for many miles? Even if the bridges should be raised, would it be equitable to say that they should be raised from 4.5 to 6.5 higher than required for tow-boats, to accommodate a possible but improbable packet line for the few days during each year when high water would prevent the packet boats from passing under the bridges? While on the question of the height of boats, attention is called to the following quotation from the report on the River and Harbor Bill for 1910, which says:

It is believed that the appropriation of $500,000 to be expended in the purchase of plant for use in connection with the work of improvement of the river will also provide for experiments to be carried on by the Government which will result in improving the present type of river freight carriers, and also that these tests can be made in no other way, since the expenditures and uncertainties involved preclude the use of private capital for the purpose. As a result of the tests or experiments it is hoped that a large saving to the country at large may accrue from decreased costs of transportation, and that a type of carrier may be developed which will also reduce the cost of all bridges across navigable streams due to lessened requirements in the matter of head room.

If the Government orders these tests made, would it be fair to the bridge interests and to the public who use the bridges to find out, after the bridges were raised, that lower boats could be built which would not require the raising of the bridges?

The quotation from the River and Harbor Bill above shows that the gentlemen comprising the committee believe the bridge interests and the public have some rights as well as the river interests.

It might be interesting to some of your readers to know what some eminent authorities have to say as to the mutual rights of traffic over and under bridges. A few quotations are here given on this feature of the question.

Secretary Root in his decision in the proceeding in 1902 against these very bridges, said:

I do not think that, having in view the relative importance and rights of the commerce over the bridges as compared with the commerce under them, even with the slackwater already provided, the obstruction of the bridges is now unreasonable.

Chief Justice Taney on the Wheeling Bridge Case, said:

The general convenience and interest of the public in the travel and trade across the river as well as on its waters must be taken into consideration.

In the case of the Escanaba Transportation Co. vs. Chicago, Justice Fields said:

The rights of each class are to be enjoyed without invasion on the equal rights of others. Some concession must be made on every side for the convenience and the harmonious pursuits of different occupations.

The same authority said in another bridge case:

In this country the navigation of a river is deemed to be free, when it is kept open for vessels cleared of such physical obstructions as would retard their passage beyond what is required for the necessary transit over the stream.

The river interests, as shown by those of them who are insisting on the raising of these bridges, do not seem to agree with the opinions just quoted, and think that their rights are paramount, no matter what inconvenience or expense the public passing over the bridges are put to, so long as they get what they want. Unfortunately, for the bridge interests, most of the engineer officers who are put in charge of inland waterways, seem to be imbued with the same opinions. The writer says this advisedly and with full knowledge of what the statement means. He, like all fair-minded civil engineers, has nothing but praise for the splendid engineering work accomplished by the officers of the Engineer Corps, U. S. A., but when the question of bridges over these rivers comes before them, they do not seem to be able to view it in any other way than through the river men's spectacles.

Colonel Newcomer writes as if this question involved no one but the bridge interests, that is the corporations owning the bridges, and the river interests, and says: "In contrast with these privately owned bridges, there is the navigable waterway belonging to the public."

Does he think that the public who use the bridges have no interest in the question and should be entirely ignored? He evidently does think so as in his entire letter he makes not a single reference to the inconvenience that would result to the millions of people who pass over these bridges yearly, or to the added expense to the team owner, and trolley companies, that must ascend steeper grades to an additional height of 13 to 15 ft.

In conclusion the writer would call attention to the copy of the pamphlet mailed you herewith, entitled "The City and the Allegheny River Bridges," published by the Civic Commission of Pittsburg. The authors are Col. Thomas W. Symons, Corps U. S. Engineers, U. S. A., Retired, and Mr. Frederick Law Olmstead, both of whom are not in any manner connected with either the river or the bridge interests, so that their opinions are entirely unbiased. On page 25, these gentlemen say that "a clear height above pool level of 37 or 38 ft. (not 47 ft. as the river interests ask for) above a 15-ft. stage will give fair, justifiable and all really needed accommodations to the navigation interests."

In another part of the report it is stated that on the new barge canal, on which Col. Symons was Consulting Engineer, being built by the state of New York costing $108,000,000, the boats must be made to fit the bridges and not the bridges to fit the boats.

Yours very truly,
Wm. Glyde Wilkins, M. Am. Soc. C. E.
Pittsburg, Pa., May 13, 1910.

RIVER TRAFFIC PASSING UNDER ALLEGHENY RIVER BRIDGES AT PITTSBURG.

	Sixth St. Bridge.		Ninth St. Bridge.		Thirtieth St. Bridge.		Ewalt St. Bridge.	
	Average per day.	Total per year.	Average per day.	Total per year.	Average per day.	Total per year.	Average per day.	Total per year.
Steam boats	13	4,745	14	5,110	8	2,920	6	2,190
Sand diggers	..	....	..	12	..	36	..	....
Dredge boats	..	....	..	36	..	60	..	6
Derrick boats	..	12	..	24	..	36	..	84
U. S. Government boats	..	168	1	365	..	54	..	72

TRAFFIC PASSING OVER HIGHWAY BRIDGES CROSSING ALLEGHENY RIVER AT PITTSBURG.

	Sixth St. Bridge.		Ninth St. Bridge.		Sixteenth St. Bridge.		Thirtieth St. Bridge.		Ewalt St. Bridge.		Total for Five Bridges.	
	Average per day.	Total per year.	Average per day.	Total per year.	Average per day.	Total per year.	Average per day.	Total per year.	Average per day.	Total per year.	Average per day.	Total per year.
Street cars	1,616	589,926	1,997	728,832	....	....	....	....	....	....	3,613	1,318,758
Carriages	180	65,700	20	7,300	....	....	13	4,754	16	5,840	229	83,585
Heavy wagons	1,053	384,345	296	108,040	317	115,705	186	67,890	136	49,640	1,988	725,620
Light wagons	1,495	545,675	479	174,835	555	202,575	192	70,080	136	49,640	2,857	1,042,805
Automobiles	464	169,360	31	11,315	....	....	8	2,920	36	13,140	539	196,735
Pedestrians	30,298	11,058,770	5,973	2,180,145	5,464	1,944,360	1,651	602,615	2,179	795,335	45,565	16,631,225
Miscellaneous	57	20,805	7	2,555	....	....	45	16,425	2	703	111	40,515
Passengers in cars	55,038	20,089,080	....	....	....	....	....	....	....	....	....	....

Are Civilian Engineers Loyal to Superiors?

Sir: I was much interested in the editorial in your issue of May 12 upon the possibility of a change in the administration of the Reclamation Service by placing at its head an officer of the Army engineering corps, and it must seem to every civil engineer who reads it that a stinging blow is to be struck at his profession.

While hoping this change will not be made, I venture to make the suggestion that there may be grounds for its contemplation, and that the Civil Engineering profession

has not fully lived up to its opportunities in the control of two current government works; the Panama Canal and the Reclamation Service. In making this suggestion the writer does not wish to be considered a partisan of the Engineering Corps of the Army for he is not; on the contrary, while never having been in the employ of the Government, he has always felt jealous for the civil engineers in the Government service under army engineering officers, and considers they have never received the credit and recognition on the part of the Government and public to which their work and attainments entitle them.

Putting aside the question of the comparative professional attainments and abilities of Civil and Army Engineers, it has occurred to the writer that there is another phase of the matter, and one in which the Civil Engineer possibly has not qualified, where he has been found wanting; and that it may be in this phase that President Taft feels himself justified in, at least, considering the change under discussion.

The phase meant is that of subordination and implicit obedience to one's superior officer, and the loyal carrying out of his plans whether or not they always accord with one's own ideas, and the sticking to the work, when once undertaken, to completion, in spite of difficulties and disagreeable conditions. This means the subordination of one's self to the success of the work in hand.

The writer felt, as doubtless many engineers did, that the Civil Engineering profession had the "opportunity of a life time" to show what it could do when Mr. Wallace was appointed Chief Engineer of the Panama Canal and when civilian engineers were put in charge of the different features of the work. The feeling continued when Mr. Stevens was made Chief Engineer. Opportunity seemed to be knocking long and loud at the door. Whatever were the reasons for the resignations of these two gentlemen, friction with their superiors, the criticism of Senators and Congressmen or offers of larger salaries, withdrawal from the work must have been more or less embarrassing to the President and Secretary of War and proof to them that they could not look to the Civil Engineering profession for continuity in the direction and execution of that great work; that it had, after having been twice tried, failed them. This is not a criticism of Mr. Wallace or Mr. Stevens, as they may have been perfectly justified, from their point of view, in withdrawing from the work; but it would seem to show that the personal and material comforts and emoluments of the Civil Engineer are paramount to the successful execution and completion of a great public work. In the opinion of the writer, the Civil Engineering profession, in the case of the Panama Canal, lost a glorious opportunity.

The Secretary of War of the eventful period of the starting of the Panama Canal is now President. He finds his administration harassed by a clash between his Secretary of the Interior and the latter's subordinates in the Land and Reclamation Departments, the latter being reinforced by the Chief of the Forestry Department. He hears his own motives impugned and defiance flung in the face of the President of the United States by government employees. He can only recall the perplexities and extra work caused by the resignations of the civil chiefs of the Panama Canal, and that since the appointment of an officer of the Army as Chief Engineer there have been no such annoyances and that work on the Canal has progressed rapidly and smoothly. It is only natural for him to assume that the appointment of an Army Officer as Chief of the Reclamation Service will produce the same pleasing results, and that discipline and obedience will be compelled. It could not be wondered at if the President should appoint an Army Officer as head of the Forestry Department.

Secretary of the Interior Ballinger has been accused of no crime. As near as the writer can make out, from the present investigation based upon the Glavis incident, he is not entirely in harmony with the methods of the previous Secretary and proposes to run his department according to his construction of law and according to his own ideas. In the opinion of the writer this is his prerogative, and it is the duty of his subordinates to give him obedience. "He was hired to be boss and he has a right to insist that he be boss." The rank insubordination lately exhibited in his department would not be tolerated for a minute in the Army, nor in any large business organization. It is the duty of a subordinate to give his chief his loyal obedience and support, or his resignation.

The writer very much hopes that Director Newell will not be removed, and that an officer of the Engineering Corps will not be placed at the head of the Reclamation Service. He would like to see civil engineers take commanding rank not only in this service but in the River and Harbor and other great national works. He believes that as far as education and experience in engineering go, they are just as capable as any other body of men; but it would seem that the Civil Engineer has something to learn from his Military brother, the foundation of whose education is obedience and subservience to discipline.

Very truly yours,

S. K. Smith, C. E., M. Am. Soc. C. E.

Vintondale, Pa., May 16, 1910.

[No one will question that loyal obedience to superior authority is an important duty of the engineer, military or civil; but the best loyalty to a chief is that which aids him toward the best results by advice, counsel and protest if need be rather than by blindly following orders.

The Reclamation Service officers have not, so far as we are aware, failed in their loyalty to the Secretary of the Interior, even though they have tried to show him wherein some of the schemes he had in mind for the Service would tend to work it injury. There is no disloyalty in that, and any chief with a proper conception of his responsibilities will value such counsel and use it for his own guidance.—Ed.]

Notes and Queries.

If "Subscriber," who wrote from St. Louis, Mo., on May 18, asking for information on septic tanks, will send us his name and address, we will take pleasure in answering his query.

A New Type of Stone Crusher.

A stone crusher which is of an entirely new design and operates on a new principle, and which presents a number of special features and advantages, is an interesting machine which has been introduced recently. Some of the machines have been installed and others are under construction. The most important feature is that the crushing is done between two rapidly revolving concave disks which are set at a slight angle to each other. This angle is variable, and the distance between the disks is adjustable also. The crushed product is thrown out between the disks by centrifugal action, so that there is no liability of choking or clogging. The special purpose of the machine is for crushing stone to the smaller sizes (1-in. and less) and delivering product of uniform size. It is claimed that its use will greatly reduce the amount of machinery and plant for recrushing at large plants, where ordinarily the rejections from the main crusher are delivered to other crushers for product of various sizes. Thus the new machine with 48-in. disks can take in stones up to 7 ins. size (such as the rejections from a large gyratory crusher), and will deliver product of any size between 3 ins. and ⅝-in. as desired. The smaller machines crush to smaller sizes. The action is a direct crushing without grinding.

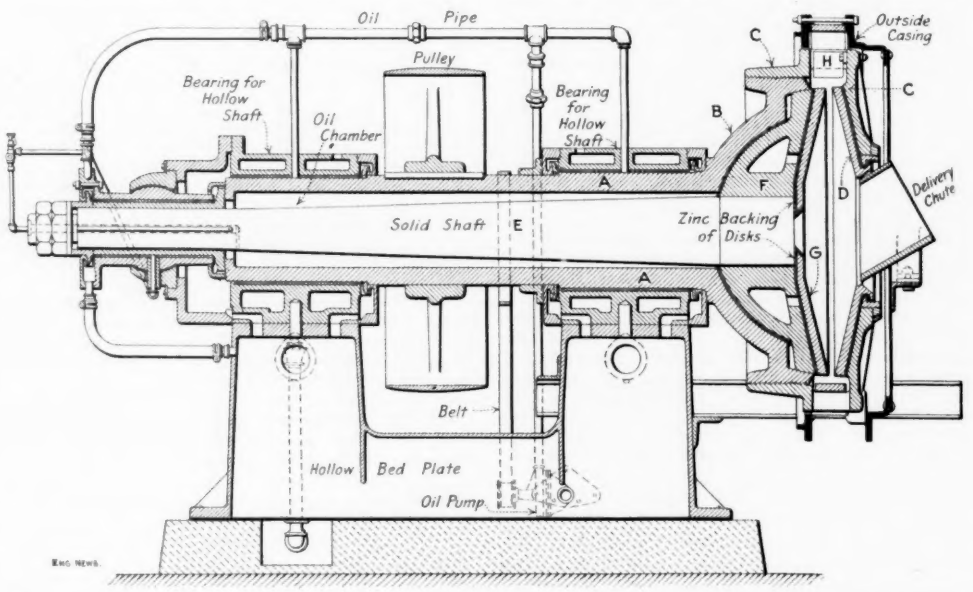

FIG. 1. SECTIONAL ELEVATION OF A NEW TYPE OF STONE CRUSHER, FITTED WITH CRUSHING DISKS.

(Symons Brothers, Chicago; Builders.)

In the sectional elevation, Fig. 1, (A) is a hollow main shaft having a hemispherical socket head (B), and around this head is a flange upon which a thread is cut. Upon this head is screwed a cast-steel cap (C) having a feed opening at the center, and on the inside of this cap is secured a manganese-steel crushing disk (D). This hollow shaft runs in two long babbitted bearings, with oil circulation and with provision for water jacketing if required. Upon it is keyed the driving pulley. Within the hollow shaft lies a solid shaft (E) to which is secured a hemispherical ball head (F), with a babbitted bearing in the socket head of the hollow shaft, forming a ball and socket joint. On the face of this ball head is secured the second manganese-steel crushing disk (G). The disks have concave interior faces. The tail of the solid shaft extends beyond the hollow shaft and has an independent tail bearing which can be traversed laterally in a horizontal plane, by means of screws on opposite sites of the bearing; one screw is slackened as the other is tightened This arrangement is shown in the sectional plan, Fig. 2, and one of the screws is shown at the rear of the machine in Fig. 3.

This movement, which is taken up by the ball and socket joint of the two shaft heads, shifts the axis of the inner shaft horizontally so that it makes a slight angle with that of the other shaft (Fig. 2). This angular position of the shafts of course sets the crushing disks at an angle to each other (while each is true on its own axis), so that the space between their faces and edges is narrower at one point than at another. The width of this space can be adjusted for any size of output by revolving the cap on the threaded flange, the cap being locked at the desired position.

The hollow shaft (with its crushing disk) is driven at high speed by a belt pulley. The inner shaft (with its disk) is not driven positively when the machine is running empty, but has a tendency to revolve due to the friction of the ball and socket bearing. As soon as the stone is introduced into the space between the crushing disks, the pressure causes both to revolve at the same speed and in the same direction. The stone thrown by centrifugal action to the wider part of the space is crushed as the width reduces (due to the angular relation of the disks). This is shown by Fig. 2, a stone lodged in the wider space (A) being carried around with the disks and crushed as the width reduces until the crushed fragments are at the narrow point (B). As soon as the fragments are small enough to pass between the edges of the disks they are thrown out by the centrifugal action, passing through openings (H) in the cap, and into a circular hood having a discharge opening at the bottom.

There is no oscillating or vibratory movement, and the crushing is done by direct pressure or squeeze between the disk, and not by any grinding action. The resistance to this longitudinal pressure (as tending to force the disks apart)

is afforded by the threaded attachment of the cap and the ball and socket joint of the shaft heads. This joint has very little motion, since both shafts revolve in the same direction and at practically the same speed. The disks do not wear in grooves but the wear is distributed uniformly over their surfaces, thus giving them a long life. The wear can be taken up by screwing on the cap.

The hollow shaft has two long bearings, fitted with babbit lining so arranged as to facilitate renewal. Oil is circulated through them by forced feed from a small centrifugal pump, driven by a belt from the shaft. The pump is attached to the hollow base of the machine, which forms an oil reservoir. The shells of the bearings are cored out with passages for water circulation in case this is found desirable for keeping the bearings cool. Any oil escaping at the ends of the bearings is intercepted by flanged collars on the shaft, and carried over into an annular chamber whose lower end discharges the oil back to the reservoir.

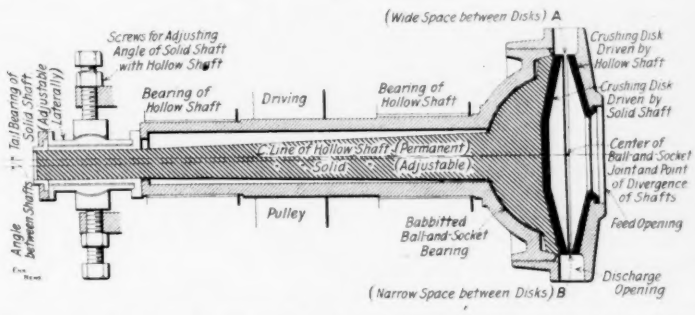
(Wide Space between Disks) A
Screws for Adjusting Angle of Solid Shaft with Hollow Shaft
Tail Bearing of Solid Shaft (Adjustable Laterally)
Bearing of Hollow Shaft
Driving
Bearing of Hollow Shaft
Crushing Disk Driven by Hollow Shaft
Crushing Disk Driven by Solid Shaft
Center of Ball-and-Socket Joint and Point of Divergence of Shafts
Line of Hollow Shaft (Permanent)
Solid (Adjustable)
Angle between Shafts
Pulley
Babbitted Ball-and-Socket Bearing
Feed Opening
Discharge Opening
(Narrow Space between Disks) B

FIG. 2. SECTIONAL PLAN OF DISK STONE CRUSHER, SHOWING VARIABLE RELATION OF SHAFTS AND CRUSHING DISKS.

The machines are built with crushing disks from 13 ins. to 48 ins. diameter. The 48-in. machine can take in stones up to 7 ins. in size (as noted above), and will crush to any desired size between 3 ins. and ⅝-in. It is run at about 250 r. p. m., and with 1-in. product its capacity is about 50 to 90 tons per hour. The 24-in. machine (which is run at 400 r. p. m.) can take 4-in. stone, and reduces it to a size as small as ¼-in.; when producing ¾-in. product its output capacity is about 20 tons per hour. The 13-in. machine (running at 600 r. p. m) can take 2-in. material and crush to sizes of ⅛-in. or less; its capacity when delivering ¼-in. product is about 7 tons per hour.

This new crusher has been invented and patented by Mr. E. B. Symons, of Milwaukee, Wis. It is being put on the market by Symons Brothers, 305 Old Colony Building, Chicago, to which firm we are indebted for information and drawings.

DRIVING CONCRETE PILES.—As yet, no soil has been encountered in which wooden piles could be driven, in which it has not been possible to drive the concrete piles. In some soils it is expedient to employ a jet; in others, an ordinary drop hammer, a steam hammer, or a combination of the jet with one or the other forms of hammer. It is necessary to lift the drop hammer somewhat more slowly for the concrete pile than for the wooden pile, in order not to set the driver into vibration. A cushion of some elastic material must be placed between the hammer and the pile, and with this precaution very little damage to the head of the pile results, even after long continued driving. As a matter of fact, it is surprising how much punishment a well seasoned pile will stand. When it is necessary to drive the pile below the leads, as is generally the case, the follower is placed on top of the cushion. As the loads on these piles are great it is necessary to drive them to refusal, so that accurate knowledge of the required length is necessary. In case it is found that the piles so driven do not reach the elevation called for on the plans, the depth of the cap is increased accordingly. If it is found impossible or impractical to drive the piles to the depth anticipated, they can be cut off without difficulty. The cut need not be a smooth one, as the casting of the cap will take care of all irregularities of the head of the pile.—From a paper entitled "Reinforced-Concrete Trestles for Railways," by C. H. Cartlidge, before the Western Society of Engineers.

Annual Convention of the National Fire Protection Association.

The fourteenth annual meeting was held at the La Salle Hotel, Chicago, on May 17 to 19, with a good attendance of members and visitors. It is the increasing custom of large hotels to give such meetings the use of their ball rooms, but while such a room provides the necessary accommodations the matter of acoustics has been given little if any consideration so that the room is not well adapted for meetings of this kind. After a single session in one room of this sort, the meeting was transferred to a very large room of which the association filled only a small part. It would seem that hotels of this class might well provide a room specially adapted for the proper accommodation of conventions, although of course available for other purposes when necessary.

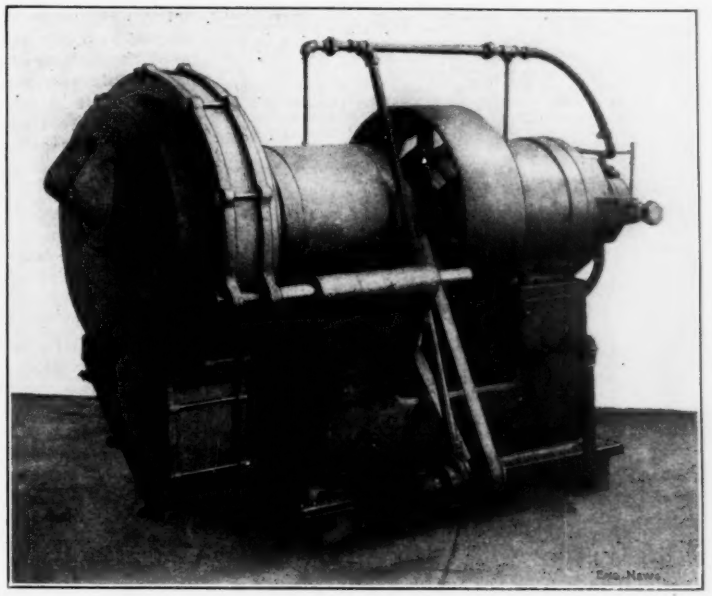

FIG. 3. THE SYMONS DISK CRUSHING MACHINE.

The proceedings opened with the address of the president, Mr. C. M. Goddard, who referred especially to the enormous aggregate loss of life and property due to fires, and also to the widespread lack of sufficient attention to methods of fire protection and prevention. In view of the importance of the subject we give herewith some extracts from the address:

Fire Losses and Fire Prevention in the United States.

Believing as I do that if the startling figures which portray our annual fire waste are kept prominently before the public, the time will come when the lesson will strike home and produce results, I shall incorporate a few such figures in this address.

The results to the individual of the enormous fire waste are usually modified by insurance, so that the loss is spread over the whole country, but the loss is there just the same, and we are all paying our portion of it. Were it not for this equalization of loss through insurance, we can hardly imagine the results of a conflagration like that of San Francisco or Baltimore to the immediate losers. Modern business could not be conducted along the present lines were it not for insurance, and it is worth our while to see that insurance does not become too dear to buy or too scarce to go around.

The state might properly take steps to compel people to realize more fully that they owe as a duty to society and to each other, the exercise of more care to prevent the occurrence of fires on their premises, which always destroy property and frequently imperil the lives and property of others. We are forbidden to expectorate in public places for fear of possible injury to others. Is it a far step to forbid by law the use of the parlor match, to which it is estimated that 600 lives are annually sacrificed? Or to enact other legislation which while it may interfere with individual comfort or convenience, yet will prove beneficial to mankind as a whole and tend to conserve our created resources, thus relieving the country to some extent from the enormous drain of our fire waste?

It is certainly no more than right and proper to require owners of buildings which are a hazard to the lives and property of others, to make such improvements as have been shown to be reasonable and effective in eliminating the fire hazard, and until such laws are enacted and are enforced, this country will continue to be an example of a woeful fire waste, largely due to carelessness and recklessness.

Why is it that in this country especially such laws and regulations are not promptly enacted or when enacted are not efficiently enforced? I believe that a careful search for an answer to this question may bring to light a fire hazard which has perhaps escaped attention, and which may be designated as the "fire hazard of a republican form of government." We have been so thoroughly educated up to the idea that individual liberty in thought, speech and act is a God-given right which no man has the right to restrict, that we have gone over the line and are claiming as an inalienable right individual "license" under the name of "liberty."

Whenever legislation is proposed to protect society against individual license, that is, legislation that interferes with the freedom of the individual for the benefit of the whole, there is sure to be strong and organized opposition on the part of the individuals and but few to take the part of the masses, for that which is everybody's business is nobody's business, and we at once hear an outcry against paternalism in our democratic government. This is probably the principal reason why it is so difficult to secure the enactment of properly drawn building regulations, or if enacted, to have them enforced. This indifference to the public weal, this selfishness of the individual who places his own convenience and success far above the welfare of his fellowmen, is the common enemy which always confronts every effort for progress or reform.

In this connection I give some quotations from a bulletin issued recently by the U. S. Geological Survey, and prepared by Mr. Herbert M. Wilson and Mr. John L. Cochrane:

The total cost of the fires in 1907, excluding that of forest fires and marine losses but including excess cost of fire protection due to bad construction, and excess premiums over insurance paid, amounted to over $456,485,000, a tax on the people exceeding the total value of the gold, silver, copper and petroleum produced in the United States in that year (1907). During 1907, fires caused the death of 1,449 persons and the injury of 5,654. These figures are incomplete and perhaps do not represent more than half the persons who were victims of fires.

It will be noted incidentally that fire protection involves the use of 2,000,000 tons of metal, having a value in excess of $127,000,000, and the metal in 350,000 hydrants, having a value of $30,000,000, all of which is wasted on account of the need of preparing to fight fires of a kind which, because of the inflammable character of building construction in this country, would develop into conflagrations without adequate water service and fire departments.

The estimated cost of private fire protection, including capital invested in construction and equipment, aggregates about $50,000,000 and the annual interest on this sum and the annual cost of watchmen's services amount to about $18,000,000. In the last 33 years, therefore, the total value of property destroyed by fire amounted to $4,484,000,000, and the figures obtained in this inquiry show that it is reasonable to assume that fully as much money was spent in fire protection, making a total of almost $9,000,000,000 in 33 years.

If the United States had Europe's per capita of 48 cts. in a total population estimated by the census bureau for 1907 as 85,532,761, the total fire waste in this country for the year would amount to $41,055,725, a saving of natural resources to the extent of $174,088,984. The results indicate that the total annual cost of fires in the United States if buildings were as nearly fireproof as in Europe would be $90,000,000, and therefore that the United States is paying annually a preventable tax of more than $336,000,000, or nearly enough to build a Panama Canal each year.

The per capita losses in the cities of the six leading European countries amounted to but 33 cts., or one-eighth of the per capita loss sustained in the United States. The average annual cost of maintaining fire departments in European cities and in American cities is 20 cts. per capita, and in corresponding cities in

the United States $1.53 per capita, or 7½ times as great. It will be noted that the per capita cost in this country and in Europe, which make up these total figures, are almost equally divided between the fire losses and the annual expense of fire protection, and that the ratio of these in the United States and in Europe is nearly the same.

The principal reason for the great difference between the amount of fire waste in the United States and Europe is that there are but few frame buildings in Europe, and practically none in the great cities. Although the prevailing use of lumber as a material of construction is one cause of the great fire waste of the United States, there is another cause lying back of this—faulty construction and equipment. The list of causes of fires is headed by defective chimneys, flues, fireplaces, and heating and lighting apparatus—faults of construction and equipment. Matches, sparks and explosions figure prominently in the list and are followed by incendiarism, electricity and lightning. Nearly one-fourth of the fires are labelled "unknown cause," which indicates forcibly the listless attitude not only of the general public toward this waste, but also of the men who are directly charged with protecting property against fire—the officials of municipalities and others.

It seems to me that no better endorsement of the course pursued by this association in its efforts to reduce the fire waste can be secured than the conclusions given in the bulletin from which I have quoted. This report gives the following three answers to the question: "How to reduce fire losses."

(1) By tests and investigations made to determine the relative fire resistance of building materials, and by the development of systems of construction which will offer maximum resistance to fire.
(2) By the dissemination of information regarding the more non-inflammable building materials.
(3) By the enactment and enforcement of building codes, with a view to ensuring more fire-resistant and more nearly fireproof construction.

The report of the Secretary, Mr. Franklin H. Wentworth, showed a development in the work of the association as the result of two years' campaign of publicity, and there is a growing increase in the number of applications to the Secretary for information as to matters of building construction and fire prevention and protection. The membership is 1,547, an increase of 218 for the year.

The reports of the Committees on Devices and Materials, on Automatic Sprinklers, on Fire Protective Coverings for Window and Door Openings and on Hydrants and Valves were received and accepted without discussion. The report of the Committee on Pumps suggested some changes in the present specifications, including the admission of other than Tobin bronze (now specified) as manufacturers are producing rolled bronze equivalent to Tobin bronze in tensile strength and other characteristics. It also permits an increase in speed for centrifugal pumps driven by alternating-current motors, the speed not to exceed 2,000 r. p. m.

The Committee on Hose had no report, but it was voted to reconsider the action of the 1909 meeting in excluding the 2-in. size. After some discussion, however, it was decided that no change should be made. The report of the Committee on Private Fire Supplies for Public Mains presented requirements as to equipment and arrangement for isolated risks and city risks. The report of the Committee on Standard Hose Couplings and Hydrant Fittings for Public Fire Service reviewed the progress in the adoption of the association's standards.

The Committee on Signaling Systems presented a set of rules and requirements for the construction and installation of municipal fire systems. It classified them as follows: (1) Manually operated systems, for cities of over 100,000; (2) semi-automatic systems, for places of 25,000 to 100,000; (3) automatic systems with fire-alarm headquarters, 5,000 to 25,000; (4) automatic systems for towns of less than 5,000. The discussion of these rules occupied a session of 2½ hours, on May 18, opening with a suggestion that the classification should be based not on population only but on the character of the town (whether manufacturing or residential) and the number of alarms required. It was voted eventually (on request of the committee) that the report as submitted should be printed in the Transactions but should be referred back to the committee for further consideration.

The report of the Committee on High Pressure Fire Service Systems was of a general character, dealing with several aspects of the subject. It was stated that there is a tendency to demand such systems where they are not needed, and if generally adopted there would be a reduction in salvage due to the use of an excessive quantity of water. The Committee on Automobile Garages submitted a series of rules covering the location, construction, equipment and use of garages. The rules included the pumps for delivering gasoline from the underground storage tanks to the charging room, but made no mention of the system of delivering the gasoline by means of air pressure in the storage tanks.

The Committee on Conference on Building Code made a report of progress. The brief report of the Committee on Fireproof Construction (including concrete and reinforced concrete) stated that the work of the committee during the year related to securing information as to fires in fireproof buildings, rather than to the preparation of specifications for fireproof construction, and it showed a great loss in non-fireproof trim, decoration and furnishings in so-called fireproof buildings. The liberal use in many cities of the building code recommended a few years ago by the National Board of Fire Underwriters indicates that a similar code with the endorsement of other associations would accomplish even greater results. It should have been impossible for New York to fail last year to secure a needed revision of its building laws because of a disagreement over the relative values of different kinds of fireproof construction. The committee expects to make progress during the next year in regard to specifications for such construction. An address on "The Architect and Fire Protection," by Mr. Irving K. Pond, President of the American Institute of Architects, had a bearing on this subject, but related also to the arrangement and planning of towns and cities.

One afternoon was set aside for a visit to the Underwriters Laboratories. This establishment includes an electrical department, chemical department, test rooms for valves, hydrants and automatic sprinklers, plant for fire and other tests of structural materials, and facilities for hydraulic and electrical work.

The election of officers resulted as follows: President, W. H. Merrill, Jr., Chicago; Vice-President, C. H. Phinney, Boston; Secretary and Treasurer, Franklin H. Wentworth, Boston. At the close of the meeting a large silver cup was presented to the retiring president, Mr. C. M. Goddard. The next meeting will be held at New York in 1911.

Correspondence Concerning the Bill to Increase the Corps of Engineers.

The bill pending in Congress to increase the Corps of Engineers and the comments upon it which we have published in our issues of April 7, April 21 and May 12 have brought to us many letters from which we have made selections for publication. As in several instances the writers of these letters do not wish their names published, we have adopted the rule in presenting the extracts from these letters below of omitting the name of the writer in every case. We may state, however, that all the contributors to the discussion write from personal experience, either as officers of the Corps of Engineers or as Civilian Assistants.

We are especially impressed with the breadth and fairness displayed by the writers in almost every case. They are aiming, we believe, at reformations which will not merely better the position of the engineers but will raise the standard of the engineering work, and that is the consideration of greatest importance to the nation.

It seems to me the Corps of Engineers is in danger of being killed by its friends, as I presume the members of the committees of Congress considering the bill are, in general, friends of the Corps. You understand the strong points of the Corps and its hold upon the public by reason of its honesty and general ability—and because, perhaps no branch of the Government service is more free from red tape, especially in those districts where the more able officers are in charge.

The great weakness of the system lies in its inability to get and keep a sufficient number of capable men, officers and employees, to do the work. The reason that officers cannot be obtained is because they must be selected from one comparatively small school, teaching military matters rather than engineering, and the number of graduates who display any engineering ability is too small; and the reason that capable civilians cannot be secured and *retained* is because, first, they must always be subordinates, and, second, the pay they may hope to receive is not sufficient. Another weakness is the idea of selecting the Chief Engineers for public works from a class of graduates 20 to 24 years of age.

The bill to increase the Corps, of very doubtful benefit to the Civilian Assistant in the first place, appears now to have lost some of the good features it once had.

Section 4 of the original bill provided that whenever it should "be necessary, in order to properly prosecute" public works, the Chief of Engineers might detail in charge of river and harbor districts, Assistant Engineers in the employ of the Engineering Department. As it has not been "necessary" to do this in the past, an increase of about 100% in the active officers under the direct control of the Chief of Engineers is not likely to create such a necessity! Why not say "whenever the Chief of Engineers considers it would facilitate the prosecution of public works, Assistant Engineers may be detailed, etc."

It has been suggested that some way be devised whereby the Corps might be strengthened by incorporating into it the best men developed among the civilian assistants. It is thought such a method would be so at variance with the traditions of the Corps of Engineers as to be distasteful to them, while the best Civil Engineers in the employ of the Department, so far as I know them, do not desire military rank.

To remedy present conditions, primarily in the interest of the organization of the Engineer Department in charge of river and harbor works, and secondarily as an acknowledgment of the work of civil engineers engaged on such works, it is suggested that a body of U. S. Civil Engineers be constituted, this title being already authorized, but held at present by but one man—Mr. Meigs. Appointment to this position should be entirely removed from political influence, the appointment resting probably in the Chief of Engineers, U. S. A., on recommendation of two or more members of the Corps of Engineers acquainted with the appointee and his work. Such appointment to be made from the grade of Assistant Engineer only, on the basis of the knowledge of the character and ability of the recipient possessed by members of the Corps of Engineers, and not upon competitive examination. Tenure of office for life, but subject to court martial by officers of the Corps, the same as members of that body. These Civil Engineers to be given no military rank, promotion to be by merit, without compulsory retirement at the age of 64 years, and with pay commensurate with experience, ability and responsibility. These U. S. Civil Engineers should then be made eligible to fill positions in charge of Engineer Districts and on Engineer Boards.

It is believed that many officers of the Corps of Engineers are desirous of giving more credit to the Assistant Engineers for their work, and appreciate the dangers of the present system. If so, they should approve a law establishing such a body of U. S. Civil Engineers, and I am satisfied that many of the best officers now in the service do favor some such arrangement.

The present bill appears to increase the Corps by adding to it men who are not so well qualified as were the present officers at the time of their appointment. It also makes the service as an Assistant Engineer less attractive because it will decrease the number of positions to which a civilian may aspire—the best of these positions being filled by the younger members of the increased Corps.

I have read, with great satisfaction, your editorial in your issue of April 7 on "The Bill to Increase the Corps of Engineers of the U. S. Army," and I wish to congratulate you upon the same. I have no doubt you might have made it much stronger if you chose, as I fully understand the situation. I have been an Assistant Engineer in the service since 1879 and have made no complaint because I knew it was useless and it would be considered generally objectionable coming from one in the service.

My view of the whole question is in no sense selfish and independent of any personal interest. I believe it is the most important matter to the whole engineering profession. Although this profession is one of the greatest in this country, as elsewhere, and has built up the country more than any other, it has received the least recognition by the Government and the people generally; all over Europe the reverse is the case.

I was in hopes that the bill would pass in its original form, more in the interest of the engineering profession generally, than in the interest of the Assistant Engineer. It has, therefore, been surprising to me that the question of this bill has not been taken up more strenuously by all engineering papers, engineering societies and engineering schools; you certainly have done your part.

The Corps of Engineers has done good work and very honest work. Much of their success is due, however, to the skill and faithfulness of their assistants. The time of an officer is so fully taken up with matters of administration that practically all of the engineering features fall upon the assistants. The officer sees, of course, that no engineering principles are violated.

Why not advocate a bill providing for the promotion of a limited number of assistants every year after rigid examinations as to fitness, with the eligibles for examina-

tion limited to those who have shown their practical efficiency through a prescribed service of a number of years? The pay of assistants in charge of districts should equal that of officers doing the same work.

My contention is for a properly organized Bureau for carrying on not only river and harbor work, but also such related work as could advantageously be combined therewith in the interest of economy and efficiency. I would like to see the personnel of such Bureau open to the best talent in the engineering profession without regard to the school from whence they might come.

There are many able men in the Engineer Corps, U. S. A., who should be included in such a Bureau, both on account of their training in such work, and also on account of the desirability of giving them a certain amount of engineering experience which might be valuable to them and to the country in case of war.

I do not believe, however, that the graduates of West Point are endowed with any extraordinary qualifications that may not be found among an equal number of engineers in civil life. They are neither better nor worse than their fellows who, coming from the people at large, enter the field of engineering.

The successful prosecution of very much larger projects in civil life, both as to cost and skill, ought to satisfactorily disprove the absurd claim sometimes made, that a military training is essential to the honest administration of public funds.

I feel that the civilian engineers who have shown faithful and efficient service should receive the recognition which they have richly earned, and any law which falls short of that should not be endorsed.

Engineers, both civil and military, come from the same source, and I cannot believe that the mere fact of graduation from different schools can materially change their natural bent as to either integrity or ability. I prefer to consider them all as American engineers, in whose success we may feel proud, and when they fail, the entire profession must share in a measure the odium attached thereto.

To my mind it is not a question of civil against military engineers at all. But it is a question of organizing a corps which can select its members from the engineering profession at large, rather than confine itself to a single school. The advantages of expanding the field from which to select scarcely needs more than the mere mention.

Duplication of work by different bureaus, and the growing disposition of each to encroach upon the field of the other, suggests that the time has arrived when co-ordination to a proper extent is necessary to the best interests of the country at large.

In your recent editorials and correspondence, there is considerable regret that commissions in the Corps of Engineers, United States Army, are not open to civilian assistants on river and harbor works. In your issues of Jan. 30 and Feb. 6, 1908, the subject of River and Harbor works as a training ground for military engineers was discussed and is worthy of consideration in the present discussion.

You regret that the Corps of Engineers is made up entirely of West Point graduates. To me it seems that the esprit de corps and pride of doing well that is engendered by that simple fact is worth many millions to the government, and that it has no objectionable features of any importance whatever. If this is so, why destroy it? What is the gain? Government work does not exist for the engineers. The engineers are the means to the end.

If the Corps were a close corporation open only by right of birth or other accidental qualification, it would be different. It is wide open at the bottom. Those who enter it are selected by four years of rigid comparison of boys drawn from every walk of life and from every State in the Union. It is as democratic as the government itself, for every Congressman has his appointee. Its raw material is as good as the country affords, and those who enter the Corps of Engineers are selected by an iron justice not equalled elsewhere on earth.

The political engineer is one of the sores on our body politic, ruinous to the country and to the engineering profession. Is it not well to have one body of engineers which is absolutely free from political control? To open the door, by the little crack you speak of, might produce far-reaching results that would ultimately destroy that one body that the political engineer now cannot enter.

Is this worth while merely to do a little better justice to the assistant engineer and to the graduate of other colleges? The latter is not seriously harmed. If he wants to get into the Engineer Corps, let him begin a little earlier and hustle for an appointment to West Point. As to the civilian assistant, it is perhaps somewhat advantageous to have engineers, in all their fields of work, grow up with the job and be gradually promoted by suitable selection to the top. This, however, seldom happens in other fields. Few railroad engineers began at the bottom on their own road or even in railroad work. Many of them have been several other kinds of engineers in several other kinds of work, and the civilian assistant who develops merit can easily get his head above water in other fields. The present Chief Engineer of the great Santa Fe system once worked with full satisfaction under the orders of an engineer officer younger and of much less experience than himself, and one of the members of the Committee of the American Society on the present bill has achieved ample success in spite of having once served under West Pointers much younger than himself.

The administration of our River and Harbor works is not entirely individual. The Chief of Engineers and the division engineers are directly over the officer in charge. The local engineer may frequently change. The work goes on just the same. It practically results in a large body of civilian engineers competent and content with routine work, leaving the administration to the bureau over them.

This type of arrangement is not unique. The most brilliant young architect in New York probably could not lay a straight brick wall nearly as well as an experienced bricklayer. Napoleon probably could not shoot or ride equal to many of his grizzled sergeants, or drill a company as well as many of his gray-haired captains. James J. Hill probably could not lay out a 5° curve to save his life or design a draw-bridge that would work, and I doubt if the Treasurer of the United States could begin to run one of the departments under him or keep its accounts with half the success of one of the veterans who now do the work, none of whom are candidates for the office of treasurer.

The world is full of just such cases, and while there is perhaps a little hardship in civilian assistants on River and Harbor work having to go into other fields to achieve high success, to my mind that drawback is trivial in comparison to the advantages and general all around inspiration that comes from having a body of men like the Corps of Engineers of the United States Army which is free from the blight of machine politics.

If West Point cannot furnish enough officers, enlarge West Point. If it is a good thing to have part of the artillery and cavalry officers trained at West Point, it would be a good thing to have all of them, and it would be a bad thing to have the Engineer Corps of the Army filled up with non-military men who would be incapable of properly and promptly performing in war time the enormously important duties of the military engineer.

[Is high standing in an engineering school course a certain indication of high engineering ability? We do not believe this is the case. Take the ten men who stand highest at graduation in the classes at Rensselaer or the Massachusetts Institute of Technology or any other high class engineering school. If one looks for the standing of those men 20 years afterward, it will be found, we are confident, that some of them have fallen behind some of their fellows who while less apt in study were better endowed with other qualities which make for success in the conduct of great engineering works. Of the honor men at West Point who are commissioned in the Corps of Engineers, a very large percentage have undoubtedly the engineering ability to back their scholastic attainments. There is a considerable proportion, however, who lack the ability to become high-class engineers. These officers usually confine themselves to executive duties and rely wholly on their civilian assistants for the technical work.—Ed.]

Allow me to express my appreciation of the stand you have taken in the matter of endeavoring to better the condition of the Assistant Engineers in the Corps of Engineers, U. S. A. I think that all the Assistant Engineers and many of the Officers of the Corps realize the present unsatisfactory condition of the Assistants. The Assistants, I am sure, would like to be given some assurance of the permanency of their positions and would like to receive some share of the credit for work well and faithfully done.

Although I am familiar with the injustice done the Assistants in the way of lack of remuneration for service rendered and the lack of credit received for designing and executing work, I have the highest regard for the Army Engineers and believe that the work of the Corps compares favorably with the work of other Engineers. If the Civil Assistants were given a position of responsibility before the world (they are responsible now only in the sense that the work in their charge must be properly done) and their remuneration was adequate to the work performed, and their places were permanent as are the positions of members of the Corps, then I would as soon serve under an Engineer Officer as under a civilian.

The Corps of Engineers as a body do not consider the Assistants as members of the Corps. The Assistants are merely assistants taken on temporarily to perform the work required of the Corps the same as a laborer. If there were enough officers to perform this work there would be no assistants from civil life. The Corps is consistent, therefore, when it supports the present measure before Congress.

That the Assistants are not considered members of the Corps was demonstrated not long since when an Engineer Board was directed to go over plans for improving a large harbor. An Assistant Engineer who had been stationed at this harbor for 25 years at least, prepared tentative plans for the improvement. His Officer thought well of the plans, but did not adopt them as his own. The Board would not consider those plans unless the Engineer Officer would present them as his plans.

The fact that Engineer Officers are stationed such a short time in one place is one of the points of weakness in planning and executing work. There may be other points in favor of this system, but an Officer is at one station barely long enough to become familiar with the conditions when he is transferred. The result is that the Assistants have to do all the designing of the work, but have not the authority to carry the designs into execution. The Officer acts as disbursing agent and can approve the plans if he sees fit. If he does not approve the plans, then something that may be unsuitable and expensive must be constructed in place of the designs of the man best fitted to perform the work. However, most Officers do approve the plans of their Assistants. Then why should not the Assistants get credit for the work performed, and also assurance of a permanent position, with remuneration commensurate with the services rendered the same as the Officer?

I would recommend for the perusal of all who may be interested in this subject the article appearing in Engineering News of May 14, 1908, by F. C. Shenehon.

[For those of our readers who desire to study the question further we heartily commend the article of Mr. Shenehon (now Dean of the University of Minnesota Engineering School) referred to above. If Congressmen would consult men of ability and experience like Mr. Shenehon, we might have some real constructive legislation in this important field.—Ed.]

Block Signal Statistics for Railways of the United States.*

During 1909, reports the Block Signal & Train Control Board of the Interstate Commerce Commission, block signaling in the United States increased in extent by 6,209.3 miles of railway, of which 2,047.1 miles represents automatic blocking and 4,162.2 miles manual blocking. It makes the total, on Jan. 1, 1910,

Automatic,	14,237.7	miles road
Manual,	51,520.3	miles road
Total	65,758.	miles road
or	85,484.	miles track

The railways included in the list have a total road mileage of 165,526, or a track mileage of 189,513.

USE OF TELEGRAPH AND TELEPHONE.—To the tables of the preceding year's report, giving the mileages of (1) all block signals, (2) the various kinds of automatic signals, (3) the various kinds of manual, and (4) the different methods of working manual signals, there has been added a table giving the mileage of line on which the telephone is used in dispatching or blocking.

A note prefaced to this table is a useful reminder of the limitations of blocking, i. e., the extent to which dispatching must prevail even on fully block-signaled lines, as follows:

> Practically all railroads use either the telegraph or the telephone for this purpose [i. e., the transmission of train dispatcher's orders which confer, restrict or change the road rights of trains], and it may be assumed that the Morse telegraph is used on roads not appearing in this list, and on those roads here shown to the extent that the telephone is not reported in use. . . . Except on lines of very light traffic, train dispatchers' orders are constantly required in connection with the movement of trains, whether the block system is or is not used; but on a line where it is not used the function of the train order is relatively more important. Without the block system a "train order" may be and usually is a vital factor in the safe movement of the train or trains affected by it. With the block system, the block signals providing the required safeguard against collision, the function of the train order may be one of convenience or celerity only.

The table shows that the telephone is used on 26,344 miles of road. The railways using it possess a total of 131,014 miles of road, thus representing nearly two-thirds of the railways of the country. The largest users of the telephone are:

*Bulletin of the Interstate Commerce Commission. For the corresponding January, 1909, report, see Engineering News of May 13, 1909, p. 520.

	Miles road—Telephone used.	Total.
Atchison, Topeka & Santa Fe lines	2,100	9,450
Chicago & Northwestern	574	7,688
Chicago, Burlington & Quincy	2,437	8,948
Chicago, Milwaukee & St. Paul, incl. Puget Sound line	972	8,943
Chicago, Rock Island & Pacific (incl. Gulf line)	690	7,923
Delaware, Lackawanna & Western	900	957
Great Northern	1,511	6,536
Illinois Central	1,716	4,601
New York Central Lines	1,942	9,145
Northern Pacific	597	5,698
Pennsylvania System	1,195	6,736
Virginian	470	472

BLOCK-SIGNALED LINE.—Thirty systems or parts of systems are recorded as being completely block-signaled. Of these, 12 have over 100 miles of line (as against 8 a year ago):

	Miles road.
Baltimore & Ohio Southwestern	973.8
Buffalo, Rochester & Pittsburg	422.0
Chicago, Burlington & Quincy	8,272.5
Chicago & Erie (part of Erie Ry)	248.8
Lehigh Valley	1,180.6
Mississippi Central	150.0
Cincinnati Northern (part of New York Central Lines)	206.1
Lake Erie & Western (part of New York Central Lines)	832.4
Lake Shore & Michigan Southern (part of New York Central Lines)	1,450.6
Michigan Central (part of N. Y. Central Lines)	1,192.1
Cincinnati, New Orleans & Texas Pacific (Q. & C.)	335.8
Western Ry. of Alabama	138.0

The following roads have over 1,000 miles of block-signaled line:

	Automatic.	Non-aut.	Total miles of road block-signaled.
Atch., Top. & S. Fe. (8,356)	110	1,450	1,560
Baltimore & Ohio (3,143) (not incl. B. & O. S. W.)	189	1,004	1,193
Chesapeake & Ohio (1,596)	48	1,534	1,582
Chicago & N. W. (7,774)	722	2,531	3,253
Chic., Burl. & Q. (8,272)	28	8,675	8,703*
Chic., Milw. & St. P. (6,550)	49	3,872	3,921
Chic., M. & Puget Sound (1,400)	..	1,076	1,076
Chic., R. I. & Pacific (7,555)	599	1,152	1,751
Erie, all parts (2,642)	86	1,543	1,629
Lehigh Valley (1,181)	481	736	1,217*
Minn., St. P. & S. Ste. M. (3,095)	...	2,186	2,186
Lake Shore & M. S. (1,451)	520	1,055	1,575
Michigan Central (1,192)	272	920	1,192†
N. Y. C. & H. R. (2,854)	209	2,631	2,840
Norfolk & West. (1,719)	138	1,507	1,645
Northern Pacific (4,994)	59	1,390	1,449
Pennsylvania Syst. (8,920)	627	5,141	5,768
Southern (6,648)	3	1,834	1,837
Southern Pacific (all) (8,435)	2,599	96	2,695
Union Pacific (all lines) (6,198)	2,097	11	2,108
Wabash (1,955)	7	1,821	1,828

*Includes some freight line not in total passenger mileage.
†243 mi. automatic blocking in Canada not included.

KINDS OF AUTOMATIC.—The distribution of automatic block mechanism is practically the same as that of a year ago:

Kind.	Miles of road.
Exposed disk	328
Inclosed disk	1,895
Electro-pneumatic semaphore	419
Electric-motor semaphore	10,664
Electro-gas semaphore	876
Total, miles of road	14,182
equals: Miles of track	23,771
and has: Block sections	24,380

Over 18,000 miles of road, of this total, is arranged on the Normal Clear plan.

KINDS OF MANUAL.—The distribution of manual blocking among the different forms of apparatus is similar to that listed a year ago. As then reported, the telegraph-block system, with 39,477 mi., is far ahead, the total road mileage of all manual systems being 51,520.

"Permissive" signaling seems to be increasing. The length of line on which this method of working is forbidden has decreased by 2,700 miles of road, to 7,833, and correspondingly the practice of permissive blocking has increased to the amount of 8,300 miles of road, to 45,382.

THE GOVERNMENT CEMENT MILL, which has been engaged for some years past in making the cement used in the Roosevelt Dam, Salt River Irrigation Project, Arizona, was permanently closed down on April 28, owing to the fact that all the cement had been made which was needed for the project. During its period of operation, 337,000 bbls. of cement were made, at an average cost of $2.90 per bbl. This cost included a depreciation charge equal to the entire first cost of the mill. The lowest bid received for the cement required for this project prior to the building of the mill was $4.89 per bbl. A total saving of nearly $675,000 is therefore credited to the enterprise by the Reclamation Service.

The Terminals of the New York State Barge Canal; Preliminary Report of the Terminal Commission.

The difficulties which have beset the authorities in charge of the New York State Barge Canal in providing adequate terminal facilities for that waterway are very well shown in the preliminary report of the special Terminal Commission appointed by the Legislature to investigate the matter. Divested of some legal verbiage and of some routine recommendations relating to the minor ports of Oswego, Tonawanda and Whitehall, the report is as follows:

The Commission has visited Buffalo, Tonawanda, Rochester, Syracuse, Oswego, Utica, Whitehall, Troy, Albany and New York, and has, at each of the points named, inspected the entire available water-front, made careful investigation as to ownership of land, in so far as possible, and in addition to personal inspection, the Commission has held one or more hearings at each of the points, inviting the members of chambers of commerce, boards of trade and other organizations and individuals interested in transportation matters to be present at said hearings and furnish the Commission with detailed information as to what, in their judgment, was necessary and desirable in the way of terminal facilities at their respective cities.

The Commission has found that a large proportion of the desirable water frontage has already been acquired by railway and steamship companies, and is of the opinion that a great portion of the success attained by these companies is due to the wise provision of adequate terminal and shipping facilities. And the Commission is further of the opinion that if the improved canals shall serve to the utmost the best interests of the State, adequate facilities must be provided for shippers transporting freight either in bulk or package form upon the waters of the canals, and that plans of the enlargement of the canals should provide proper dockage therefor.

The general proposition to furnish adequate termina's at various points along the canals is so large, and at many points so intricate, that your Commission is not at this time prepared to submit a full and complete report with recommendations; but it deems it advisable at this session of the Legislature to call particular attention to the conditions existing in the city of Buffalo, the Tonawandas, the city of Oswego, the village of Whitehall, and the borough of Manhattan in the city of New York.

In the city of Buffalo, the State now possesses valuable lands under water, basins, canals and uplands which, at comparatively small expense, and in connection with concessions which the city of Buffalo is disposed to make for canal terminal purposes of land that it owns, suitable and adequate terminal facilities may be provided for the accommodation of freight received by or to be shipped over the canals from that point. But this Commission is unprepared at this time to describe the character of the terminals that should be erected at that city. The Commission earnestly recommends that all properties owned by the State in the city of Buffalo be retained. . . .

Beginning in colonial times and extending to the present, the colony and the State of New York have ceded to the city of New York without expense, extensive and valuable lands under water, together with certain uplands adjacent thereto. The State has also ceded to owners of adjacent uplands certain lands under water until, to-day, the State owns no land along the foreshore of the borough of Manhattan.

Various railroad companies now own or control, either in fee or through long-time leases, a large portion of the Manhattan water frontage. The remaining frontage is largely owned and controlled by steamship companies or private individuals, and the commission is of th opinion that the falling off of freight transported on the canals, either in bulk or package form, is largely due to the inability of the shippers to avail themselves of even necessary facilities. The Commission, therefore, recommends that the Legislature take such action as in its judgment it deems necessary to enable the city of New York to cede back to the State of New York, subject to existing leases, to be used solely for public purposes, and at all times under the supervision of the State of New York, dockage property at the foot of 75th St., at the foot of Vestry St. (or new pier 29), and at the foot of Rector St., all on the Hudson River; also on the East River at what is known as the canal basin, between and including piers 3 to 8, at Corlear's Hook, and at a point yet to be determined upon between 35th and 42d Sts. To accomplish this desired end, we present a bill as a part of this report and recommend its passage.

The commission is not unmindful of the manifest advantages and the great commercial value of large tracts of land in other boroughs of the city of New York, especially in the neighborhood of Newtown Creek, Wallabout Market, Gowanus Bay, Jamaica Bay, Staten Island and The Bronx. These points have all been v ited and inspected by the commission, and their pa ticular advantages are being considered. The Co mission has been impressed with the need, especial in the city of New York, of a comparatively large general terminal, especially for the accommodati of the import and export trade, as distinct from domestic and local trade of that great port, and in t final determination by this Commission of the proper cation of additional terminal sites in the port of N York, each of the places named will receive its mo careful consideration.

A POWDER MILL EXPLOSION May 19 near Nanai B. C., wrecked the separator plant of the Hamilt Powder Co. Five men were killed.

A DYNAMITE MAGAZINE IN CUBA at the ba racks of the rural guard at Pinar del Rio was wreck May 18 by the explosion of some 3,000 lbs. of dynamit It is reported that 35 persons were killed and about 1 others injured. The accident is officially ascribed to the attempt of a carpenter to repair a defective bo which was one of several, filled with dynamite, that w being loaded on a wagon for transportation to th railway station. The explosion of the dynamite on th wagon was followed at once by that remaining in th magazine. From press reports, it appears that th dynamite was stored in a building immediately adjacent to some of the barracks and officers' quarters.

A LAKE STEAMER WAS SUNK May 23 in a collision on Lake Huron, 25 miles north of Pointe Aux Barques, Mich., near the mouth of Saginaw Bay. The steamer "Frank H. Goodyear" was struck amidships by the bow of the steamer "James B. Wood" and sank within a few minutes. Only five of the 23 persons on board the "Goodyear" were saved. The "Wood," although badly damaged at the bow, was able to reach port at Port Huron. The collision occurred at about six o'clock in the morning and is ascribed to a fog. The "Frank H. Goodyear" was owned by the Susquehanna Transportation Co., of Buffalo, N. Y., and was operated by Mitchell & Co., of Cleveland, Ohio. She was 436 ft. long with a net tonnage of 3,438. The "James B. Wood" is a somewhat larger vessel.

THE SECOND AEROPLANE FLIGHT across the English Channel was made on May 21, the feat being performed this time by one Jacques de Lesseps, grandson of the late Ferdinand de Lesseps. The trip was made from Calais to Dover, in a dense fog which prevented the projected return to Calais which was to have been made without alighting at Dover. The reported time of the trip was 50 minutes; the first trip across, made by Louis Bleriot on July 25, 1909, was reported to have occupied only 25 minutes.

A VERDICT ON THE CHERRY MINE DISASTER has been reached by the coroner's jury and throws a part of the blame for the heavy loss of life upon negligence of State mine inspectors. The verdict for the men killed in the second vein is as follows:

We find that they came to their death by suffocation and that the fire was caused by a pitched load of baled hay coming in contact with an oil torch. And we further find that there was great delay in notifying the men of their danger.

The following separate verdict gives the cause of the deaths in the third vein:

We find that they came to their death by exposure and suffocation. We further find that the mining laws of the State of Illinois in relation to means of escape were violated with the full knowledge and consent of the Mine Inspectors for District No. 2.

A brief account of the Cherry disaster, which occurred Nov. 13, 1909, and caused the deaths of 265 men, was published in Engineering News, Nov. 18 and 25, and Dec. 2, 1909. The earlier reports stated that the fire in the mine originated with an explosion, but it was later ascertained that there was no explosion—only a rapidly spreading fire.

AN ENGINEERING CONVENTION HALL has been tendered the American Street and Interurban Railway Association by business interests in Saratoga Springs, N. Y. The only condition is that the association shall agree to meet in Saratoga Springs for three years out of the next five. If, at the end of the five years, the receipts for rent of exhibition space, etc., are equal to the original gross cost of the proposed building, the building and land are to become the sole property of the railway association. The building would be about 300 × 400 ft., and would cost about $150,000. It is reported that the rent paid in the past three years at convention halls (plus the miscellaneous rent which the proposed hall might earn) would exceed this sum. Definite acceptance or refusal of the tender has not been announced.

AN ENGINEER OF BUILDINGS is being sought by the Bureau of Buildings of Manhattan borough, New York City. While the title of the position is Assistant

Engineer, with salary $4,000 per year, the position actually is that of Chief Engineer of the Bureau, with principal duty to act as adviser to the head of the Bureau. A high-class engineer is wanted, with thorough knowledge and experience and sound judgment. A competitive examination will be arranged by the Civil Service Commission to select candidates. The Superintendent of the Bureau, Mr. R. P. Miller, was himself formerly Chief Engineer to the Superintendent. He apparently prefers to separate his present administrative functions from the functions of technical expert.

A FIVE-LEVEL SUBWAY CONNECTING STATION is projected by the New York Central & Hudson River R. R. to connect its Grand Central Terminal in New York City with the several present and proposed rapid-transit subways which reach the Terminal: The existing Interborough subway, the Hudson Tunnel extension now under construction, the New York & Long Island (Steinway or Belmont) Tunnel, and the Broadway-Lexington Ave. subway soon to be started by the Public Service Commission. As the latter will be double-deck at this point, it will require two levels in the connecting station, making five below ground.

THE PATTERSON RESERVOIR in the Croton drainage basin of the water-supply of New York Ctiy, has been reported against by Mr. John J. Delany, a court referee appointed in a taxpayer's injunction suit backed by the Merchants' Association of New York and others. The report must be confirmed by the court to become effective. The reservoir was proposed several years ago by the recently removed Aqueduct Commission and was the subject of much local controversy, both as to the need for it and the authority of the Commission to build it in view of the refusal of the Commissioner of Water Supply, Gas and Electricity to approve the plans.

RAPID TRANSIT IN TORONTO is to be investigated for the City Council, with a view to planning rapid-transit subways and (in the outlying districts) surface railway connections. The Council has engaged the firm of Jacobs & Davies, Inc., of New York, to investigate and report on the subject. Mr. Charles M. Jacobs and Mr. James Forgie have already looked over the ground in a preliminary way, and the latter will represent the firm at Toronto in the full investigation. The present problem is to study the entire transit situation, the present street-railway system, and the necessary arrangements for handling the traffic in the best way, present and future. With regard to the City's right to construct underground lines within the city limits and surface lines outside, report is to be made as to the most desirable and feasible location for such lines, the probable cost of construction, equipment and maintenance, the probable business, and the prospects of the systems being self-sustaining.

CONTINUED OPPOSITION TO THE PASSAIC VALley Sewerage Project is announced by the Metropolitan Sewerage Commission of New York in a special report to Mr. Wm. J. Gaynor, Mayor of New York City, dated May 23, 1910. The New York Commission urges that the agreement between the U. S. Government and the Passaic Valley Sewerage Commission, published in full in our issue of May 12, 1910, does not provide for purification works adequate for the protection of New York Bay; that the U. S. Government appears to have granted undue authority to the Passaic Valley Commission, if indeed it has not exceeded its legal powers of stipulating what degree of purity the sewage effluent shall have before discharge into the Bay; that the people of the city and State of New York should be given assurance that no nuisance will result from the works; and finally that the city of New York apply to the U. S. Supreme Court for permission to intervene in the suit brought by the State of New York against the Passaic Valley Sewerage Commission. The recommendation as to intervention is in effect an attempt on the part of the New York Commission to prevent the State of New York from following the lead of the U. S. Government by discontinuing the suit in question. The report on which this note is based states that the suit will probably "be withdrawn unless continued for some unexpected reason," and then supplies the unexpected by making the recommendation just cited. The members of the Metropolitan Sewerage Commission of New York are: Messrs. George A. Soper, James H. Fuertes, H. de B. Parsons, Charles Sooysmith, M's. Am. Soc. C. E., and Dr. Linsly R. Williams.

REBUILDING THE KENTUCKY CANTILEVER bridge, known as the "High Bridge," carrying the Cincinnati Southern Ry. over the Kentucky River, at a point 103 miles south of Cincinnati, is an important and difficult work now in progress. The present bridge is a single-track structure having a central span of 375 ft. and two shore spans also of 375 ft. each, while the rail level is 275 ft. above the river. It has parallel-chord trusses about 30 ft. deep. It was built in 1876-77 to the designs of C. Shaler Smith, as modified on the suggestions of T. D. Lovett, then Chief Engineer of the railway. It is notable for the fact that while originally designed as a continuous structure, it was converted into a cantilever structure by cutting the lower chords. The bridge and its erection were discussed very fully in our issues of March 23 and July 6, 1905.

The new bridge will be a double-track structure with spans of the same length, supported by towers on the original masonry piers, these piers having been enlarged to carry the wider towers. It will have trusses about 70 ft. deep, and will be of much heavier construction than the old bridge on account of the increase in wheel loads and train loads during recent years. It will carry the track at a height about 30.8 ft. higher than the present rail level in order to eliminate the 1% approach grades, the present bridge lying at the bottom of a sag.

The erection will involve some very interesting work, as the towers and trusses must be built around and independently of the present structure, which, of course, must be kept open for traffic. Work of this kind on a smaller viaduct on the same road was discussed in our issue of June 8, 1905. Material for the new bridge is being delivered, and work will be commenced in the spring. The substructure work has been completed and was done by the railway company's forces. For this work a small concrete mixing plant was placed on each pier, the material being delivered by cars on the bridge and dumped into track hoppers having 8-in. pipe chutes leading to the pier.

The plans of the new structure have been prepared by Mr. G. Lindenthal, M. Am. Soc. C. E., of New York, who is consulting engineer for the railway company on this work. The contract for the superstructure has been awarded to the American Bridge Co. Grading for the south approach has been done by the Mason & Hanger Co., of Richmond, Ky., and that for the north approach by Oliver Bros. & Honeycutt, of Knoxville, Tenn.

THE TOTAL PARK AREA OF NEW YORK CITY at the close of 1909 was 7,221 acres, according to a statement issued by the Committee on Congestion of Population in New York (50 Church St.). The distribution of this acreage by boroughs, together with the corresponding borough population per acre of park area, and the per capita assessed valuation for each borough is as follows:

	Distribution of acreage by boroughs, acres.	Population per acre of park area.	Assessed valuation per capita of each borough.
Manhattan	1,444	1,589	$165.55
Brooklyn	978	1,268	31.50
The Bronx	4,134	83	86.83
Queens	602	211	10.07
Richmond	63	1,127	3.31

The total assessed valuation for all the park lands in Greater New York in 1909 was $418,085,650, or about one-half of the total city debt. It is stated that about one-third of the cost of Central and Prospect Parks was assessed upon the property benefited.

A BOARD OF PUBLIC UTILITY COMMISSIONERS for New Jersey has been created by Chapter 41 of the Laws of 1910, recently approved by Governor Fort. The statute is an amendment to an act of 1907 which created a Board of Railroad Commissioners. The name of this board has been changed to that stated above, and its jurisdiction has also been extended

to include every railroad, express, street railway, traction, canal, subway, pipe line, gas, electric light, heat and power, water, sewer, telephone, telegraph or other corporation, association or joint stock company, operating within the state of New Jersey for public use, under privileges granted by the state or by any municipality thereof.

The Commission is to have "general supervision over all public utilities" as defined in the act, and is given "power, after hearing upon notice, by order in writing" to require every public utility as defined in the act:

(a) To comply with the laws of this state relating thereto, and to perform the public duties imposed upon it thereby;
(b) To furnish safe and adequate service;
(c) To keep its books, records and accounts so as to afford an intelligent understanding of the conduct of its business, and to that end to require every such public utility of the same class to adopt a uniform system of accounting;
(d) To direct any public utility, as herein defined, found to be granting rebates, or other unjust, unfair and unreasonable discriminations to immediately cease therefrom.

Said commission shall also have power to investigate any accident happening in connection with the operation of any public utility, as herein defined; to hear and examine complaints concerning rates charged by any such public utility, and to make such recommendations as it may see fit concerning accidents and rates.

In furtherance of the foregoing powers, said commission shall also have power to compel the attendance of witnesses and the production of papers, accounts and documents, to swear witnesses and issue subpoenas, all in the manner provided in the act to which this is an amendment and supplement.

The Commission is given certain powers of control over the issuance of stock and securities of public utility companies, and over leases and consolidations of such companies. The act also provides that no franchise hereafter granted by any local governing body shall be valid unless approved by the Board. Public utility companies are authorized by the act to appeal to the Commission from orders or regulations made by local governing bodies. The act prohibits any public utility company from granting free service or any gratuity or discrimination of any sort upon any "local, municipal or county official," but this prohibition is restricted so as not to include free transportation of uniformed public officers engaged in their duties. Members of the Board are to receive salaries of $6,000 per year, and the salary of the secretary is limited to $4,000 per year. The total expenses of the Board, including salaries, are limited to $50,000 per year.

A UNIVERSAL WATER-METER SYSTEM for New Bedford, Mass., was ordered by the City Council in 1909, according to the report of the New Bedford Water Board for last year. The Water Board was directed to install meters in all unmetered premises "with all reasonable despatch and diligence" from and after July 1, 1909. A meter rate of 15 cts. per 1,000 gals. was fixed for all domestic consumers, including city departments, and of 10 cts. per 1,000 gals. for water used for manufacturing purposes. The water taker has the option of buying the meter, or having the city supply and install the same at a rental of 10% on the cost of the meter and its installation. The minimum meter rates are fixed at $2.50, $3.75 and $5, "when only that amount would be charged under fixture rates." Mr. Charles S. Ashley is Mayor of New Bedford and President of the Water Board, and Mr. Robert C. P. Coggeshall, as many of our readers know, is Clerk of the Board and Superintendent of the Water-Works.

THE PROBLEM OF CLOSING THE ATCHAFALAYA River has again been brought actively before the Mississippi River Commission. The Atchafalaya is practically the last important side outlet of the Mississippi, the other bayous by which part of the waters discharged having been successively closed off. The Red River formerly entered the Mississippi at the westerly extremity of a long bend in the latter stream, and at the same bend the Atchafalaya headed, carrying some of the water to the Gulf by a shorter course than the main stream. In 1831 the bend of the Mississippi was cut off by Capt. Shreve, under orders, and the remains of the bend are now called Upper and Lower Old River. The Red discharges mainly through the Atchafalaya, but these two exchange flood waters with the Mississippi, to some extent, via Old River. This connection has been silting up rapidly, and has been kept open for navigation only by dredging. At one time there were fears that the Mississippi would enlarge the Atchafalaya and ultimately abandon its own lower channel. Mattress sills were laid across the Atchafalaya at Simmesport, just below its head, in the late '80s, and there has been no enlargement in recent years. As the waters of the Mississippi entering via Old River cause much flooding in the lower reaches of the Red River, a complete separation of the two parallel systems has been advocated. This would cut off communication by vessel, but for two years there has been a lock at Plaquemine, farther down the Mississippi, which connects with bayous leading to the Atchafalaya, so that there is now a navigation connection. Requests to the Commission to close Old River have been made by the Police Jury of West Baton Rouge parish, and by the Commissioners of the Red River and Bayou des Glaises Levee and Drainage District. The Mississippi River Commission during its recent inspection trip along the river heard evidence on the subject. The pending River and Harbor bill makes provision for a full examination and report on the question. The chief objection to the closure of Old River appears to be on the part of those who fear that the flood volume of the Mississippi below Red River Landing may be increased, i. e., the flood levels raised, by preventing outflow to the Atchafalaya.

THE FIRST LOCKAGE THROUGH THE NEW YORK Barge Canal was made on May 9 at the lock at Baldwinsville, N. Y. This section is on Contract 45, which is now practically completed, and consists mainly of a short section of canal and a lock around the falls in the Seneca River at this town. The machinery for the locks has not as yet been installed and the gates were opened with a block and tackle to let a dredge and work boat through from the upper to the lower river. During the present season this section of the new Barge Canal will not be utilized for through traffic, all such traffic passing through the old Erie Canal some miles south of the new line.

A NEW "TELHARMONIUM."—The "Telharmonium," an invention for the production of music by imposing certain alternating currents on a "receiver," much like a telephone receiver, was described in Engineering News, Feb. 28, 1907, as installed at 39th St. and Broadway, New York City. The inventor, Dr. Thaddeus Cahill, of Holyoke, Mass., has now completed his third arrangement which is the largest "telharmonium" yet assembled. This is now described in the "Electrical World" for April 28. In the older system the more notes sounded on any one keyboard, the less loud each single note became.

This "robbing" has been prevented by a rearrangement of the electrical circuits to eliminate the effects of the reactions of the many circuits acting together on the receiver. A new receiver has been designed, having a diaphragm some ten times the diameter of a telephone receiver but only three times as thick. Due to the arrangement of the energizing magnets and of the air passages, a single receiver responds satisfactorily, it is claimed, to any sound from deepest bass to highest treble, to a single note of a pure tone or to a full chord of composite tones. The many generators are built of greatly increased capacity, especially in the high-frequency machines for producing the higher pitched notes. It was noted in the earlier article in Engineering News that the "voices" of various orchestral instruments could be reproduced. In the latest "telharmonium," with a number of switchboards and keyboards for several musicians, there has been possible an approach to orchestral tones and a departure from the limitation to organ or single instrument tones alone.

A 70-FT. EARTH DAM has been built in Switzerland in a power development on the Löntsch, a small mountain stream in Canton Glarus, northeastern Switzerland. The crown length of the dam is about 710 ft. The height of crest above original ground surface at the maximum section is 70.5 ft. The highest storage level is to be 6½ ft. below the crest. The dam has a heart-wall of sandy clay reaching down about 20 ft. below the bottom of the dam itself, with a top thickness (1½ ft. below crown of dam) of 10 ft. and side batters of 1 in 6. Selected fine material was placed next the core-wall, ordinary material outside of this to form the main body of the embankment, and coarse gravel and stone in a layer about 5 ft. thick on both slopes (to protect against burrowing animals). The water slope and the crown are paved with stone block 20 ins. thick. The slopes are 1 on 2; the water slope has berms 6½ ft. wide at elevations 13 ft. apart vertically, while the down-stream slope has berms 4 ft. wide at vertical intervals of 16 to 20 ft. The structure is described briefly in the "Schweizerische Bauzeitung" of April 23. It is there stated that to make sure of the stability and tightness of the dam, the impounding of water was done very gradually, in stages of 12 to 15 ft., holding the water at each height for some time to give full opportunity for leaks or other trouble to become manifest.

A HYDRAULIC MOTOR for use in opening and closing valves on water-works systems was shown in actual use at New Orleans, La., during the recent convention of the American Water-Works Association. Where conditions demand it, these motors may be installed permanently and thus always be ready for use. Otherwise, they may be moved about on a repair or other wagon, as needed. In portable form the motors may be used with convenience and economy in periodically testing valves to determine whether they are in working condition. It is stated that a 36-in. valve can be opened in 3 to 5 minutes and others in proportion. When set permanently the motor is placed directly over the valve and connected with the water main by a valve-controlled feed pipe. When used in portable form the motor is attached to the nearest hydrant by means of a hose. The motor is made by the A. P. Smith Mfg. Co., of Newark, N. J.

Personals.

Mr. Ellsworth Shoecraft, recently City Engineer of Coldwater, Mich., has become City Engineer of La Porte, Ind.

Mr. Wm. A. Mackenzie, formerly of Bridgeport, Conn., has been recently appointed Engineer and Superintendent of the Wallingford Water Works and also Borough Engineer of Wallingford, Conn.

Mr. J. C. Muir, Division Superintendent of the Chicago & Eastern Illinois R. R. at Danville, Ill., has been made General Superintendent of the Evansville & Terre Haute R. R. to succeed Mr. J. O. Crockett.

Mr. I. B. Richards, Superintendent of Transportation of the Northern Pacific Ry. at St. Paul, Minn., has been made General Superintendent at Tacoma, Wash., to succeed Mr. B. E. Palmer, resigned.

Mr. John F. Stevens, M. Am. Soc. C. E., has become President of the United Railways Co., of Portland, Ore. Mr. L. B. Wickersham has been made Vice-President and Chief Engineer of the same company.

Mr. L. K. Devendorf has left the engineering department of the Canton Bridge Co., with which he had been connected for the past eight years, and has entered the employ of the Standard Oil Co., in the road-oil department.

Mr. William S. Twining, Assoc. Am. Inst. E. E., has resigned his position as Chief Engineer of the Philadelphia Rapid Transit Co. and will be associated, after July 1, with the firm of Ford, Bacon & Davis, of New York City.

Mr. G. W. Martin, General Manager of the Washington, Frederick & Gettysburg Ry., has become Vice-President and General Manager of the Philipsburg & Susquehanna Valley R. R., with headquarters at Philipsburg, Pa.

Mr. Charles E. Perkins, M. Am. Soc. C. E., retired May 21 from his position as Chief Engineer of Public Works of the State of Ohio, and has opened an office for the practice of civil engineering at Akron, Ohio. Mr. Perkins had served 18 years in the position he has just left.

Mr. F. H. Reagan, Assistant Superintendent of Shops of the Lake Shore & Michigan Southern Ry. at Collinwood, Ohio, has been made Master Mechanic of the Lake Erie & Western R. R. and is succeeded in the former position by Mr. B. F. Kuhn, formerly General Foreman of the locomotive shops.

Dr. W. Colby Rucker has been appointed Commissioner of Public Health of Milwaukee, Wis. In order to be eligible for this appointment Dr. Rucker has obtained leave of absence from the U. S. Public Health and Marine Hospital Service, in which he has attained distinction through his success in stamping out plagues.

Mr. Henry S. Jacoby, Assoc. Am. Soc. C. E., Professor of Bridge Engineering at Cornell University, has been granted a leave of absence for the first half of the next academic year. He expects to start July 1 on a tour of seven months in the United States and Canada, visiting municipal and railway bridge departments and important bridges and other structures.

Mr. Lawrence A. Downs has been recently appointed Assistant Engineer of Maintenance of Way of the Illinois Central R. R., Yazoo & Mississippi Valley R. R. and the Indianapolis Southern R. R. Mr. Downs is a graduate of Purdue University, class of 1894, and has been in the service of the Illinois Central since 1896. His latest position previous to the recent appointment just noted was as Assistant to the Chief Engineer of Maintenance of Way of the Illinois Central.

Mr. A. W. Buel, associated until recently with Mr. Virgil G. Bogue, M. Am. Soc. C. E., of New York City, has opened offices for the practice of civil engineering at 15 William St., New York City. He will specialize in bridges and structural work. Mr. Buel has been absent from New York during the greater part of the past year, engaged in revising the design and completing plans for the two steel travelers for "Ohio River Bridge No. 1," Allegheny Co., Pa., a cantilever bridge of 750-ft. span. Plans for the bridge are now completed but Mr. Buel is still retained as consulting engineer for the contractors on erection.

Mr. Frederick M. Mann, Professor of Architecture at Washington University for the past eight years, has been appointed to a similar chair in charge of the department of architecture at the University of Illinois. Mr. Mann is a graduate of the University of Minnesota in civil engineering, class of 1892, and took the degree of Master of Science in Architecture at the Massachusetts Institute of Technology in 1895. He was given the degree of Civil Engineer by the University of Minnesota in 1898. Among the structures he designed during several years of professional practice in Boston and Philadelphia is the class of 1873 memorial gateway at the University of Pennsylvania.

Obituary.

Martin Hughes Gerry, Fleet Engineer under Admiral Farragut at the battle of Mobile Bay, died May 18 at his home in Minneapolis, Minn.

Albert G. Starke, Secretary and Treasurer of the firm of A. Schrader's Sons, Inc., of New York City, manufacturers of diving apparatus, died May 12.

Richard Price Morgan, consulting engineer, of Dwight, Ill., died at the Hahnemann Hospital, Chicago, on May 20 at the age of 82. He had had a large and varied experience in railway work, and is said to have been employed as a rodman on the original survey of what is now the Hudson River division of the New York Central & Hudson River R. R. He was a member of the Illinois Railway Commission when it was first established. He established the firm of Richard P. Morgan & Son, civil engineers and railway experts. He became a member of the Western Society of Engineers in 1887, and a few years ago was given the degree of Doctor of Engineering by the University of Illinois.

William Phipps Blake, M. Am. Inst. M. E., Director Emeritus of the Arizona School of Mines, and Territorial Geologist of Arizona, died May 22 at Berkeley, Cal., from pneumonia. Professor Blake was born in New York City in 1826 and was graduated from the scientific school at Yale University in 1852. After graduation, he became Geologist for the U. S. Pacific Railway Exposition. In 1859-60 he was editor of the "Mining Magazine" and in 1864 he began a term of several years as Professor of Mineralogy and Geology in the College of California. He re-entered the service of the United States Government in 1871, when he was sent with a commission to Santo Domingo. After taking part in a number of expeditions he became Director of the School of Mines, University of Arizona, in 1894. He became Director Emeritus in 1905.

Engineering Societies.

COMING MEETINGS.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 31-June 3. Spring meeting at Atlantic City, N. J. Secy., Calvin W. Rice, 29 West 39th St., New York City.

ENGINEERS' SOCIETY OF PENNSYLVANIA.
June 1-4. Annual convention at Harrisburg, Pa. Secy., E. R. Dasher, Gilbert Bldg., Harrisburg, Pa.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
June 7-9. Annual convention at Detroit, Mich. Secy., Richard Moldenke, Watchung, N. J.

MASTER CAR BUILDERS' ASSOCIATION.
June 15-17. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 20-22. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 21-24. Annual convention at Chicago, Ill. Secy., Chas. W. Hunt, 220 West 57th St., New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 22-24. Semi-annual meeting at Niagara Falls, N. Y. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 23-25. Annual meeting at Madison, Wis. Secy., Henry H. Norris, Cornell University, Ithaca, N. Y.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 27-30. Annual convention at Jefferson, N. H. Secy., R. W. Pope, 33 West 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 28-July 2. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
June 30-July 1. Semi-annual meeting at St. Louis, Mo. Secy., W. M. Mackay, P. O. Box 1818, New York City.

MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.—At the meeting of May 25, a paper entitled "Economic Aspects of City Planning" was presented by Mr. Benjamin C. Marsh.

AMERICAN RAILWAY ASSOCIATION.—At the annual meeting May 18 in New York City, Mr. Daniel Willard, President of the Baltimore & Ohio R. R., was elected President of the association. Mr. H. V. Mudge was elected Vice-President, and Mr. C. R. Gray and I. G. Rawn were elected to the executive committee.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The annual meeting was held at the Engineering Societies Building in New York City May 17. Two papers were read: "Some Developments in Modern Lighting Systems," by C. W. Stone, and "Metal Filament Lamps," by John W. Howell. Officers for the coming year were elected as follows: President, Dugald C. Jackson, Massachusetts Institute of Technology; Vice-Presidents, P. H. Thomas, New York; H. W. Buck, New York, and Morgan Brooks, University of Illinois; Managers, H. H. Barnes, New York; C. E. Scribner, Chicago; W. S. Rugg, New York, and R. G. Black, Toronto; Treasurer, Geo. A. Hamilton, Elizabeth, N. J.; Secretary, Ralph W. Pope, 29 West 39th St., New York City.

AMERICAN HIGHWAY LEAGUE.—At the meeting held in Chicago on May 13 and 14, and noted in our issue of May 19, p. 598, the President was authorized to appoint a committee to draw up standard specifications for highway bridges. The importance of this feature of highway work was commented upon, and the necessity for specifications to meet present conditions and practice was brought out clearly in the discussion on this subject.

Action was taken also to encourage each department to present to the American Society of Civil Engineers all data concerning bituminous macadam construction, the object being to have data as uniform as possible. It is expected that as a result of this the highway engineers will be able to formulate more definite specifications for various bitumens than are now practicable.

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.—The annual convention will be held at Syracuse, N. Y., Aug. 23-26. The program includes addresses on the following topics: "Practical Use of the Automobile Fire Engine," Chas. S. Allen, Trenton, N. J., and Frank G. Reynolds, Atlanta, Ga.; "High-Pressure Fire Service; Its Operation and Efficiency," E. F. Croker, New York City, and J. E. Buchanan, Winnipeg, Canada; "The Necessity of Quick and Accurate Notice of Location of Fires," Wm. L. Riehl, Cincinnati, Ohio; "The Value of Fire Cisterns," H. L. Stanton, Norwich, Conn., and H. F. Magee, Dallas, Tex.; "Use and Abuse of Automatic Sprinklers," J. J. Conway, Cincinnati, Ohio, and J. O. Glanville, St. Louis, Mo.; "Safe and Sane Storage and Handling of Gasoline," Fred. Morrison, Watertown, N. Y., and W. B. Cummings, Atlanta, Ga.; "The Automobile Combination Wagon for Fire Service," Harry L. Marston, Brockton, Mass., and Hugo R. Delfs, Lansing, Mich.

Among the subjects which will be open for general discussion are the following: The fireproof skylight; value of an automatic gas cut-off; possibility of ignition of wooden floors by steam pipes.

The secretary is Mr. James McFall, Roanoke, Va.